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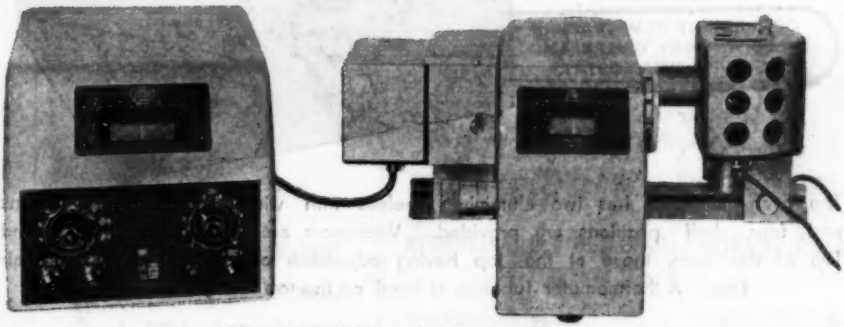

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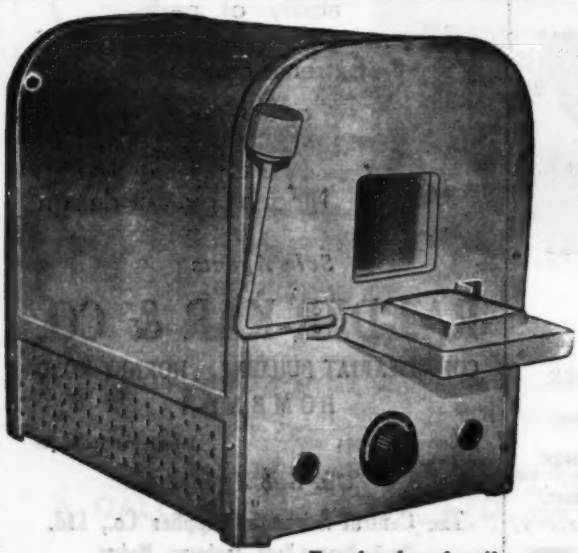

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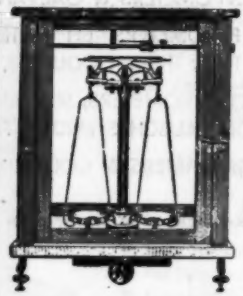

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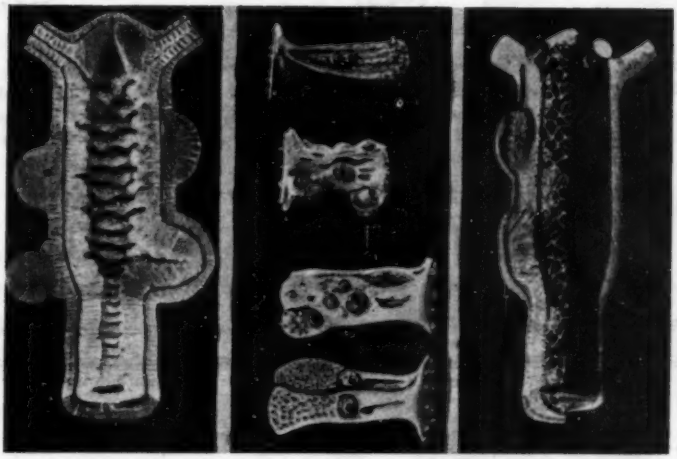

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PROF. S. CHANDRASEKHAR AS ASTROPHYSICIST*

PROF. CHANDRASEKHAR'S work as an astrophysicist is so fundamental in quality and pervasive in its range that it is difficult to present a summary of his work in the course of a single lecture. However, an attempt is being made here to indicate briefly the nature and extent of his contributions which make him one of the greatest astrophysicists of our age.

Stellar Structure

Violent nuclear collisions can result from thermal motion if a material is heated to a high temperature. The reaction $Li^7 + H^1 = 2\,He^4$ can be observed at as low as 8 KeV thermal energy, that is, of the order of $10^{8\circ}$ C. In such a thermal nuclear reaction, every particle becomes a bombarding nucleus and therefore we have an isotropic bombarding of particles, of density comparable to that of the material itself. Of course, it must be kept in mind that only the high energy tail of the Maxwell distribution contributes effectively to these reactions.

Whereas the temperatures necessary for such reactions even among the lightest elements are beyond any laboratory possibilities on earth, they are quite common in the cosmos and in fact, form the principal source of stellar energy. These reactions take place in the hot interior of the stars. Chandrasekhar's book on stellar structure relates to mathematical problems involving such physical conditions in stellar interiors. His work reveals the comparative simplicity of the theory of stellar structure due to the fact that at such high temperatures, the stellar material is completely ionised and forms an ionised gas. Hence the physical properties of such an ideal gas mixture of bare nuclei and nuclear electrons can be predicted with great accuracy. Particular mention must be made of Chandrasekhar's contribution to the structure of the red giant stars. He has shown on the basis of observational material that red

* Abstract of lecture delivered by Dr. Alladi Ramakrishnan at the Presidency College, Madras, on the occasion of unveiling the portrait of Prof. S. Chandrasekhar (an old student of the College), by Dr. A. L. Mudaliar, Vice-Chancellor, University of Madras.

giants possess a much higher central condensation of material than normal stars of the main sequence. Whereas in a normal point source model 90% of the stellar mass occupies one half of the stellar radius, the red giants have the same mass condensed within 25% of the radius from the centre.

The study of white dwarfs presents a new aspect of the theory of matter of the super dense state. Chandrasekhar has made extensive calculations regarding the external ratio and the internal density distributions for degenerate white dwarf configurations of the various total masses and hydrogen content.

Chandrasekhar has also contributed to the theory of the origin of chemical elements and the explanations for abundance curves based on the hypothesis of dynamical equilibrium between various nuclear species at a certain high density and temperature. Among other workers in the field may be mentioned Weizscaker, Stern and Watagin. The entire work on stellar structure is embodied in two classic works—*Introduction to the Study of Stellar Structure*, 1939, and *Principles of Stellar Dynamics*, 1942.

Radiative Transfer

Chandrasekhar can be reckoned to be one of the founders of the subject of radiative transfer. The scope of that work is best defined by quoting the excellent preface to his own book on that subject. "The problem of specifying radiation field in an atmosphere which scatters light in accordance with well-defined laws dates back to Lord Rayleigh's investigation in 1871 on the illumination and polarisation of the sunlit sky. But the fundamental equations governing Rayleigh's particular problem had to wait seventy-five years for their proper formulation and solution. The subject was given a fresh start under more tractable conditions when Arthur Schuster formulated in 1905 a problem in radiative transfer in an attempt to explain the appearance of absorption and emission lines in stellar spectra and Schwartzchild introduced in 1906 the concept of radiative equilibrium in stellar atmospheres. Since that time the subject of radiative transfer has been investigated principally by astrophysicists, though in recent years the subject has attracted the attention of physicists also, since essentially the same problems arise in the theory of the diffusion of neutrons."

Chandrasekhar's work on radiative transfer is embodied in his third and probably the most mathematical of his books. In this book he has attempted to present the subject of radiative transfer in a plane parallel atmosphere as a branch of mathematical physics with its own characteristic methods and techniques. On the physical side the novelty of the methods used consists in the employment of certain general principles of invariance, which on the mathematical side leads to the systematic use of non-linear integral equations and the development of the theory of a special class of such equations. On these accounts the subject would seem to have an interest which is beyond that of the specialist alone: at any rate, that has been his justification for writing this book. However his own partiality had led him to include two chapters which are probably of interest only to the astrophysicist.

Statistical Astronomy

The third important field to which Chandrasekhar made his important contribution is "Stochastic Processes and Statistical Astronomy". In 1943, there appeared in the *Reviews of Modern Physics* one of the most important papers in the history of statistics. No single quasi-expository paper has attracted so much attention and has been quoted so often as that classic one on 'Stochastic Processes in Physics and Astronomy'. Perhaps it is permissible to say that here he forestalled the statistician in demonstrating the possibility of application of the abstract theory of stochastic processes to physical problems. It was only six years later that papers of a similar type appeared and that too from statisticians steeped in probability theory and *not* physicists. In 1950, with his collaborator G. Munch, Chandrasekhar started his work on statistical astronomy, with a series of papers 'On the Fluctuations of the Brightness in the Milky Way'. His interest soon turned to the theory of turbulence, a field made famous by men like Heisenberg, G. I. Taylor, Von Karman and Kolmogoroff.

Delivering the Henry Norris Russel lecture on 'Turbulence, a Physical Theory of Astrophysical Interest', he said, "I have chosen to describe to you the recent advances in our understanding of the phenomenon of turbulence in the belief that these advances are relevant to the progress of astrophysics. Perhaps, it is premature to take an occasion like this to describe a physical theory which is yet to establish its relations to astronomical developments. But the history of astronomy and astrophysics shows that major advances in our understanding of astrophysical phenomena have coincided with and depended upon advances in fundamentals of physical theory."

Chandrasekhar's prediction soon came true. Today, turbulence is playing a central role in the understanding of the structure of interstellar matter. Weizscaker has outlined a general cosmogony, the essential feature of which is the prominent role ascribed in the interplay turbulence and rotation. Martin Schwartzchild has extended the Heisenberg theory of turbulence to include the agency maintaining turbulence for the case when the turbulence results from thermal instability. It has important applications in the interpretation of solar granules.

Chandrasekhar has turned his attention in recent years to the new and fascinating field involving the interplay of hydrodynamics, electromagnetic theory and turbulence. Even more recently, he associated himself with Fermi, in work on interstellar magnetic fields.

Finally, a few remarks about Chandrasekhar's general attitude towards science and research may not come amiss. Chandrasekhar has preserved the two most lovable characteristics of the pure scientist, an unbending desire for freedom of thought and expression combined with quiet confidence. Any estimate of Chandrasekhar's contribution as an astrophycist is incomplete if reference is not made to the great school of astrophysics he has created. Even a casual glance through the volumes of the *Astrophysical Journal* during the past twenty years will reveal that a considerable fraction has been stimulated by suggestions of Professor Chandrasekhar. He was made the Managing Editor of that famous Journal a few years ago. But the best tribute to a scientist is to attempt to emulate his example and pursue science with passion, humility and confidence, qualities which sum up the characteristic of a true student of science.

SYMPOSIUM ON CRYSTALLOGRAPHY

THE International Crystallographic Union held a symposium in Madrid from 2-7, April under the patronage of *Consejo Superior de Investigation Cientificas*, Spain. The three topics discussed during the symposium were: (1) Structure on a scale between the atomic and microscopic domains, (2) Open Meeting of the Commission of Crystallographic Apparatus, and (3) On Crystallographic Teaching.

Prof. Wyckoff in his Presidential Address pointed out the scope and importance of the study of macromolecules by electron microscopic and X-ray methods and the valuable results these studies have yielded. He also stressed the necessity of discussing the methods of teaching employed in various centres of crystallographic study.

Over fifty papers were read on structural studies in the submicroscopic domain using X-ray as well as electron microscopic and electron diffraction techniques. Special mention may be made of the beautiful electron micrographs exhibited by Prof. Wyckoff having such a fine resolution as to show up even details within the molecule in shadowed replicas of macromolecular crystals. A large number of papers dealt with texture studies of metals and alloys as well as other substances of commercial interest like grease and coal. The small angle scattering from fibres and individual particles was the subject of a number of theoretical and experimental investigations. The correlation of the data revealed by X-ray diffraction and electron microscopy was also discussed. The Commission for Crystallographic Apparatus discussed new apparatus and methods to tackle special crystallographic problems. Papers presented dealt with microfocus and rotating anode tubes, special cameras for single crystal counter diffractions, a miniature Weissenberg camera with a film radius 5 mm. and cameras for small angle scattering studies. Parrish stressed the advantages of using focussing monochromators for the X-ray diffractometer and also the superiority of scintillation counters wtih pulse height discriminator over the G-M counter in eliminating dead time effects, increasing quantum efficiency, producing higher peak to background ratio and in being capable of detecting even sulphur K radiation (5·5 Å).

The session of the Commission on Crystallographic Teaching started with invited papers dealing with special aspects of teaching crystallography and was followed by a lively discussion. The opening paper was by Prof. Bernal on the 'History of the Present Status of Crystallographic Teaching'. The paper, "Lecture Demonstrations in Crystal Physics", by Prof. A. V. Shubnikov (U.S.S.R.) accompanied by beautiful short films clearly demonstrating the various aspects of crystal growth, simple models for dislocations and vacancies, etc., was one of the highlights of the session, and created very wide interest and discussion on the advantages of the use of motion picture demonstrations in explaining phenomena to students.

There were discussions regarding the type of courses that a student with a limited time at his disposal could avantageously undergo. The technique of teaching the subject, logical difficulties of comprehending the ideas involved in space groups and symmetries and the necessity of propaganda to create more widespread understanding of the capabilities of X-ray crystallographic techniques were some of the other topics discussed.

At the closing session of the symposium the President expressed his gratitude to the patron for extending the invitation to the Union for holding the symposium in Madrid and for all the hospitality extended during the period.

GOPINATH KARTHA.

TUBERCULOSIS VACCINES

IT is now more than thirty years since a live vaccine containing B.C.G. (bacille Calmette-Guérin) was first used in man. In the interval B.C.G. vaccination has come to be accepted in many countries as an effective method of preventing progressive tuberculosis, and it has been particularly widely used since 1945. In 1937 Wells discovered the mycobacterium of vole tuberculosis, and later explored the use of a live vaccine containing it. Vole-bacillus vaccine has since been used in a few countries, but on a very small scale compared with B.C.G. vaccine. Its value as a preventive measure has also not been fully assessed.

In July 1949, the British Medical Research Council, aware that a clinical trial of these two vaccines was needed to provide essential information, appointed a Tuberculosis Vaccines Clinical Trials Committee to plan and direct an appropriate investigation. The first report of this trial, which is still in progress, has been published in a recent issue of the *British Medical Journal* (February 25, 1956, p. 413).

During the two-and-a-half years after entry to the trial the total number of participants known to have died was 38. None of these deaths was due to tuberculosis, and there seemed to be more than chance differences between mortalities in the various groups. Among the vaccinated children 99·6% of those receiving B.C.G. and 94·4% of those receiving vole-bacillus vaccine became tuberculin-positive. However, the potency of the batch of vole-bacillus vaccine used in the earlier part of the trial was low, and of 1,900 who were vaccinated with the later batch all became positive reactors to tuberculin.

The children who have been under observation for a longer period up to four years, provide some further information. The intervals between entry to the trial and the earliest manifestation of tuberculosis in the unvaccinated negative reactors and in the positive reactors showed interesting differences. On the whole, in the groups of positive reactors the incidence of evident tuberculosis was fairly even over the first three years whereas among the unvaccinated negative reactors the incidence during the first year was notably lower, and only during the second year reached approximately the same levels as those of the group showing high tuberculin sensitivity on entry. This can presumably be correlated with the fact that these children left school and started to run a greater risk of infection with tuberculosis within 6-12 months after entry to the trial. Another important point which this extended analysis shows is that the more favourable experience of the vaccinated children was maintained during the whole of the four years of observation.

This trial has shown beyond doubt the benefit of B.C.G. vaccination for adolescents in an urban industrialized community. The study of all participants, including those initially tuberculin-positive, has permitted an assessment of the benefit to be expected from routine B.C.G. vaccination in this particular group of subjects; the apparent reduction in the incidence of tuberculosis over the period of two-and-a-half years as a result of giving B.C.G. vaccine to all those initially tuberculin-negative would have been of the order of 35%. The high incidence of tuberculosis in those who were initially highly sensitive to tuberculin emphasizes the desirability of including in a scheme of B.C.G. vaccination provision for frequent re-examinations of this group. The question of the relative merits of vole-bacillus vaccine and B.C.G. is to be the subject of a further study. Certainly it appears at present that the vole-bacillus vaccine gives rise to a higher incidence of undesirable immediate effects.

Not enough is known at present to allow the prescription of an optimal age for vaccination and if there is indeed such an age it may well vary with changing circumstances. The best compromise might be to offer vaccination to school children as a routine at the age of about 12—a little earlier than in the trial, since 40% of the participants were already infected on entry—and to make vaccination against tuberculosis conveniently available at any age to children whose parents request it.

MECHANISM OF SELENIUM DIOXIDE DEHYDROGENATION OF FLAVANONES

N. R. BANNERJEE AND T. R. SESHADRI

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THE use of acetic anhydride as solvent for selenium dioxide dehydrogenation of flavanones has the advantage that the method can then be used for hydroxy compounds also. The preparation of diosmetin[1] and luteolin[2] from hesperidin by this method has already been reported. In the course of these experiments, the formation of a small amount of a by-product was noticed. The glycosides, hesperidin and naringin as well as the corresponding aglucones, hesperetin and naringenin have now been subjected to direct selenium dioxide oxidation in the presence of acetic anhydride and the products worked up in the same way; the glycosides underwent hydrolysis during the treatment with dilute sulphuric acid for deacetylation. In all these cases the corresponding flavones, diosmetin and apigenin were predominantly the major products which could be obtained pure by crystallisation. The accompanying by-products could be identified by paper chromatography to be the corresponding flavonols, namely, tamarixetin[3] and kæmpferol respectively. That this was not due to the presence of impurities in hesperidin and naringin obtained from natural sources as well as in the products of their hydrolysis, hesperetin and naringenin, was proved by the fact that each of them gave a single ring on filter-paper chromatogram.

Oxidation of Hesperidin and Hesperetin

Selenium dioxide (1 g.) was boiled in acetic anhydride (25 c.c.) with either hesperidin[2] or hesperetin (1 g.) or either of their acetates[1] (2 g.) in an oil-bath at 155-65° for 6 hr. Metallic selenium was filtered off and the deep brown filtrate was poured on to crushed ice. The yellow solid was boiled with alcoholic sulphuric acid (7%; 50 c.c.) for 2 hr., diluted with water (50 c.c.) and extracted with ether and the ether solution evaporated. The brown residue crystallised from aqueous alcohol as yellow needles, m.p. 251-53°. Yield, about 60%. It had all the properties of diosmetin,[4] Rf 0·67 (acetic acid—water, 1 : 2, 25°, Whatman Filter-Paper No. 3); ring appeared after spraying with ammonia. The aqueous alcoholic mother liquors gave a yellow ring (Rf 0·49); on spraying with dilute ammonia another yellow ring (Rf 0·67) appeared. Two brown rings were formed on spraying with alcoholic ferric chloride (1%) instead of ammonia. Tamarixetin[3] gave a yellow ring (Rf 0·49) and when it was mixed with the above mixture, a single yellow ring (Rf 0·49) appeared before spraying and another yellow ring (Rf 0·67) on spraying with dilute ammonia. An experiment with double the quantity of selenium dioxide did not appreciably increase the yield of flavonol.

Oxidation of Naringin and Naringenin

It was carried out exactly in the same manner and with the same proportions as in the above cases. The brownish yellow product obtained by hydrolysis was crystallised from aqueous alcohol when apigenin, m.p. and mixed m.p. 341-43° crystallised out. Yield, about 60%. The mother liquors revealed on filter-paper chromatogram a yellow ring, Rf and mixed Rf with kæmpferol (*i*) 0·35 (acetic acid-water, 1 : 3), and (*ii*) 0·81 (phenol-water, lower layer) without spraying. Spraying with aqueous ammonia revealed another yellow ring, Rf and mixed Rf with apigenin 0·48 (acetic acid—water, 1 : 3).

Oxidation of 5 : 7-Dimethoxy Flavanone

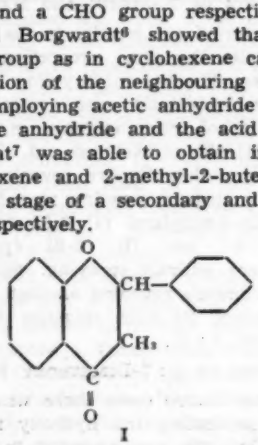
In all the above cases there was some difficulty of separating the hydroxy flavones and flavonols but this was expected to be got over by using 5 : 7-dimethoxy flavanone in which the resulting flavonol can be easily separated from the flavone using its solubility in alkali. Though the separation was effected it was noticed that the alkali-soluble portion contained two products, one agreeing with galangin 5 : 7-*O*-dimethyl ether and the other with 2-hydroxy-4 : 6-dimethoxy chalkone. The chalkone may have been produced by the opening up of the flavanone ring by the boiling acetic anhydride. The relevant particulars are given below.

The crude oxidation product from the flavanone (1 g.) was taken up in ether and repeatedly extracted with cold aqueous sodium hydroxide (5%). The residual ether extract yielded 5 : 7-dimethoxy flavone as colourless needles m.p. and mixed m.p. 149-50°. Yield 70%. The alkaline extract was acidified and extracted with ether. The residue obtained on evaporation gave two yellow rings Rf 0·49 and 0·92 on filter-paper chromatogram (acetic acid-water 1 : 3, solvent). On spraying with alcoholic ferric chloride (1%) they turned brown and reddish violet respectively. Mixed chromatography with galangin 5 : 7-*O*-dimethyl ether

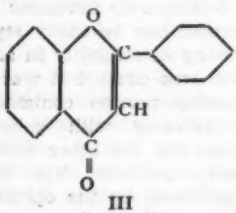
(Rf 0·49) and 2-hydroxy-4 : 6-dimethoxy chalkone (Rf 0·92) revealed no new rings.

Mechanism of Dehydrogenation

The yield of the flavonol in all these experiments is, however, very small and does not interfere in the preparation of the corresponding flavone in a pure condition; but its production is of significance in regard to the mechanism of selenium dioxide oxidation of flavanones. It was shown by Riley *et al.*,[5] that a methylene group as in cyclohexanone and a methyl group as in acetone located adjacent to an activating carbonyl can be oxidised by selenium dioxide to a CO and a CHO group respectively. Schwenk and Borgwardt[6] showed that even an ethylene group as in cyclohexene can activate the oxidation of the neighbouring CH_2 group to CO. Employing acetic anhydride or a mixture of the anhydride and the acid as solvent Guillemonat[7] was able to obtain in the case of cyclohexene and 2-methyl-2-butene the intermediate stage of a secondary and a primary alcohol respectively.



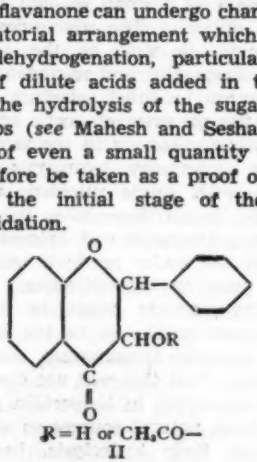
I



III

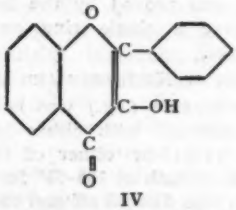
When two methylene groups are associated with activating carbonyl groups on either side the result has been dehydrogenation to form an ethylene, *e.g.*, acetonyl acetone to diacetyl ethylene[8] and ethyl succinate to ester of fumaric acid.[9] The conversion of a flavanone (I) into a flavone (III) is a similar dehydrogenation[10] (the activating groups being a carbonyl and a phenyl group) and was usually carried out using xylene or amyl alcohol. Though this dehydrogenation may appear at first sight to be different from the other examples, it falls into line with others if an intermediate hydroxy or acetoxy stage (II) could be recognised, because the final product can then be formed by the facile elimination of a molecule of water or acetic acid. The detection of flavonols as minor products of the reaction of flavanones may be significant on this account.

In oxidations involving the use of halogens and silver acetate, lead tetra-acetate and hydrogen peroxide the methylene group of flavanones gets hydroxylated (acetoxylated) and the C-OH bond formed thereby has the axial orientation, leading to ready elimination of water (acetic acid) forming flavones. This seems to happen in the oxidation with selenium dioxide also. Further, as in the other cases, simultaneously, a small portion of the hydroxy (acetoxy) flavanone can undergo change into the C-OH equatorial arrangement which is favourable for dehydrogenation, particularly in the presence of dilute acids added in the present work for the hydrolysis of the sugar and acetoxyl groups (*see* Mahesh and Seshadri[11]). The formation of even a small quantity of flavonol could therefore be taken as a proof of hydroxylation as the initial stage of the selenium dioxide oxidation.



R = H or CH_3CO—

II



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MULTIPLE SPOT PHENOMENON IN INORGANIC CIRCULAR PAPER CHROMATOGRAPHY

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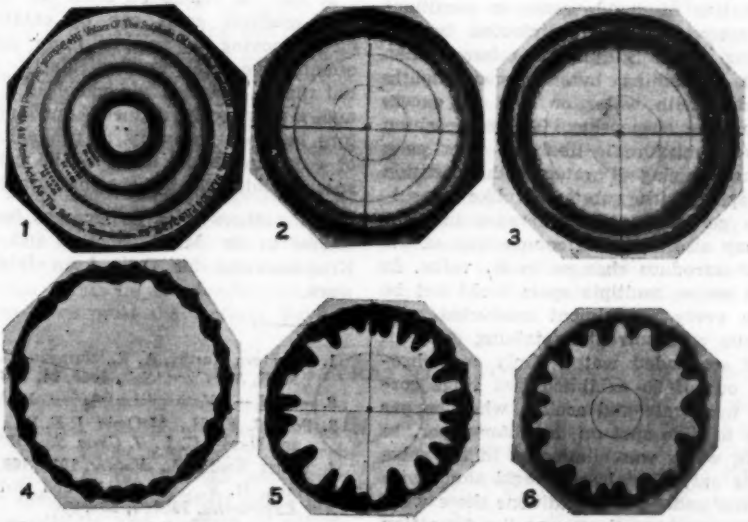
DURING our studies of circular paper chromatography of inorganic ions, certain peculiar results were noticed in some cases (about 10%) although uniform experimental conditions were maintained. A brief account of such results is given in the present communication.

The general technique of chromatography was the same as described earlier.[1] Whatman No. 3 filter-paper discs were used throughout. 0·05 ml. of solution which was 0·05 M. with respect to the salt was used for each experiment. The metallic bands were identified by spraying ammoniacal hydrogen sulphide. The chromatographic experiments were carried out in airtight chambers at $27 \pm 1°$ C.

It was shown[2] that cations like copper and cadmium can be separated into different bands corresponding to several anions associated with the metal such as sulphate, chloride, nitrate and acetate (Fig. 1) when irrigated with a solvent like butanol saturated with 4 N acetic acid. It was found subsequently that even a pure single substance such as copper acetate gave rise to two rings after irrigating the spotted disc with butanol saturated with dilute acetic acid (1, 2, 3 N) (Fig. 2). Similarly when copper nitrate was chromatographed with the solvent, butanol saturated with 3 N acetic acid, the metallic band separated into two rings corresponding to nitrate and acetate (Fig. 3). Copper chloride also exhibited two rings, one of which was due to chloride and the other to acetate. Lead acetate irrigated with a solvent containing ethyl alcohol acetic acid and water developed two rings similar to copper salts. It was also noted that no such clear separations occurred when the irrigating solvent contained hydrochloric acid (3 N) instead of acetic acid.

In some other instances, the metallic bands exhibited a peculiar shape in the contour. Fig. 4 was obtained with copper chloride irrigated by *n*-butanol-6 N acetic acid (1 : 1). Fig. 5 is a chromatogram developed by copper chloride with the solvent butanol-5 N acetic acid (1 : 1). Cadmium sulphate gave rise to a star-shaped picture (Fig. 6) when chromatographed with butanol-5 N acetic acid (1 : 1). It is difficult to explain how these distorted pictures are obtained. Surface tension and differential wetting would play an important role



in the spreading of the solution at the initial stages but it has not been possible to identify the surface active substance which influences such a course of development.

The possibility of such a separation of metallic bands corresponding to different anions associated with the cation has been accounted for[3] on the basis of the equilibrium in the process of elution of a salt A^+B^- by a mobile phase containing C^- which can compete with B^+ for A^+

$$A^+B^- + C^- \rightleftarrows A^+C^- + B^-$$

When the acid H^+C^- is present in the irrigating solvent, the formation of AC depends on its strength and on its concentration. The hydrogen-ion concentration of the solvent medium influences the mobility of the ions to a considerable extent. While this can explain partly the separation of copper chloride or nitrate into two bands corresponding to (1) chloride and acetate, (2) nitrate and acetate in the above mentioned cases it is very difficult to account for the separation of copper acetate or lead acetate into two bands with the same solvent, *viz.*, butanol-acetic acid.

The formation of double zones in partition[4] chromatography has been attributed to the water-logging of the kiesulguhr column when the solvent containing butanol was slightly undersaturated with water or held an excess of water in fine suspension. The composition of the solvent mixture is likely to alter as a result of such logging of water in the partition chromatography with substances like kiesulguhr, silica gel or paper. Difference in temperature may also alter the composition of the solvent and introduce changes in R_f value. In the present series, multiple spots could not be obtained in every experiment conducted with butanol-acetic acid solvent containing different amounts of suspended water. Only two chromatograms out of 20 exhibited two rings corresponding to nitrate and acetate when copper nitrate was used to spot on the filter-paper. In a few trials, water was eliminated in the solvent by using only glacial acetic acid along with butanol. Even under such conditions there were a few instances where there was the formation of double rings of copper associated with nitrate and acetate. It was noticed that a wide halo surrounded the metallic band in a few cases. In the light of the present observations it is extremely difficult to say that water content of the mobile phase greatly influences the chromatogram.

It has been observed that multiple spots are developed when the solvent used for irrigation contained a complex forming reagent with the metal under test, such as ammonia in the case of cadmium[5] or aceto-acetic ester in the case of cobalt[6] or benzyl acetone with copper.[3] Such a separation of a single metal into different zones is attributed to the formation of different complexes which move with different R_f values. It should be noted that the present authors have obtained such clearly separated metallic bands even in the case of single common ion between the test solution and the solvent without the presence of any complexing reagent. "Ghosts" and "shadow" spots found along with the metallic spots were attributed to the alkaline earth and heavy metal impurities[7] in paper in the case of the separation of phosphoric esters. In the present case, however, the analysis was mainly with metals such as Cu, Cd or Pb which remain unaffected even in the presence of such impurities in the paper.

It may be concluded from the present work that multiple spots can be obtained with a metal moving as two or more species. For quantitative analysis particularly, it is essential that a metal should move as a single band and give sharply defined boundary. It therefore becomes necessary to run a large number of experiments in order to be certain of the species obtained by chromatographic analysis.

The authors wish to express their grateful thanks to Dr. M. R. A. Rao and Prof. K. R. Krishnaswami for their keen interest in the work.

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THE TRAINING OF UNIVERSITY TEACHERS

WHILE the presentation of a subject in the lecture room may be impeccable as regards content, quite often it leaves much to be desired in the matter of teaching technique. Ways and means for improving this aspect of the matter are suggested by S. Radcliffe in the *Bristol University Review* (Vol. 28, No. 1, Oct. 1955).

According to Radcliffe the following are a few of the purely mechanical skills which might be considered desirable in a good teacher or lecturer. First, the adoption of a fitting speed and clarity of diction. Secondly, the clear formulation and appropriate stressing of the main points of the subject under review. Thirdly, the ability to use a blackboard successfully. Fourthly, the 'staging' of material to make it come 'alive'. The correct lighting and ventilation of the lecture room are of importance. A few weeks teaching in any school will bring these and many allied points home.

What is a fitting speed and clarity of diction? How many lecturers ask their students whether they can hear clearly, or whether they are speaking too quickly for them? A teacher can soon learn the correct measure in these instances with the aid of a little guidance. The undue dropping of the voice at the end of each sentence, for example, can produce both monotony and inaudibility. A person with a weak voice can be shown how to make the most of it by someone trained in these matters. This is a problem faced by teacher-training departments.

The clear formulation and appropriate stressing of the main points of the subject cover a large number of factors. Just as the potential teacher must learn how to arrange and present the various points he is intending to convey in a lesson, so must the lecturer have a clear and systematically arranged plan of what he intends to talk about. He must know which points are important or difficult enough to require particular stressing, either in the form of repetition or slower and more deliberate speaking, or even by the dictation of vitally relevant matter.

The extent to which the blackboard is used will obviously vary with the nature of the lecture; a statistical, technical or linguistic theme will call for more blackboard writing than, say, a literature or philosophy lecture. Titles of works, proper names, unusual or foreign terms, dates—all these should be written up to ensure that students get the correct form. The writing must be clear and legible, and not scattered about in disorder on the board.

Lastly, Radcliffe elucidates his reference to the proper 'staging' of material. There is an element of the histrionic in all personal teaching; the teacher is to some extent an actor, who must make his material come to life. There are some generally recognized devices into the application of which the tyro could with advantage be initiated. A slight break before passing on to a new theme in a lecture can be most refreshing for all concerned. An occasional pause to receive questions from students will in certain cases add to the effectiveness of the lecture; it "draws the students in" more and gives the lecturer a chance to gauge their grasp of what he is saying. Learning the students' names is an essential requirement in establishing such closer contact with them. The prompt return of written work not only helps to keep up students' interest in their subject, but also gives the right to demand written work from the students within the time-limit specified.

PREPARATION OF ILLUSTRATIONS FOR PUBLICATION

ILLUSTRATIONS in the form of drawings or graphs are often the most important feature of a scientific paper, and many research workers with little or no previous experience in the matter sometimes unwittingly cause considerable extra trouble and expense in editorial offices by submitting illustrations which require a great deal of alteration before they are suitable for reproduction. Most journals have their own peculiarities, and before submission of a paper intending authors should examine the particular journal they have in mind to see, for example, if any particular form and size of lettering is favoured. In this connection intending authors could not do better than consult "Notes on Preparation of Illustrations", prepared by the Editorial Office of the *Biochemical Journal* (price 1 *sh.*, from the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W. 1). This gives simple instructions, and deals with the essentials of the matter in a particularly direct way. Its acquisition by departments and/or individuals for the modest outlay of about a rupee is a worth-while investment.

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PRODUCTION FUNCTIONS FOR LARGE-SCALE INDIAN ESTABLISHMENTS

Econometric models for net output in terms of the main factors of production, *viz.*, labour and capital, have been derived by the author. The present note is a brief report on the detailed paper to be published in *Sankhya*. The Douglas-type production function, *i.e.*, a function which is linear in the logarithms, has been fitted by the least square method for large-scale Indian establishments for the years 1948 to 1952. Cross-section data, as published in the *Reports of the Census of Indian Manufactures* for the major industries, have been used.

In non-logarthmic form the above type of production function would appear as

$$P = a_0 L^{a_1} C^{a_2} \qquad (1)$$

where P is the value added by manufacture, L represents the contribution of labour and C that of fixed and working capital employed in the manufacture.

In the present study P and C are in lakhs of rupees, and L is the number of lakhs of man-hours put in, obtained from the following expression for the total man-hours:

$$2400n_s + m + \tfrac{2}{3}w + \tfrac{1}{2}c \qquad (2)$$

where n_s is the number of salaried workers (supposed to be working 8 hours a day for 300 days in the year), m, w, c are the hours of work put in during the year by men, women and children respectively, and 2/3 and ½ are ratios between the work of an average woman and child wage-earner respectively to that of an average man wage-earner.

The values of the constants a_0, a_1, a_2 in equation (1), the last two being respectively the

elasticities of production with respect to labour and capital, are set out in the following table:

Year	a_0	a_1	a_2	$a_1 + a_2$
1948	·602	·625	·376	1·001
1949	·747	·566	·400	0·966
1950	·792	·421	·533	0·954
1951	·677	·549	·431	0·980
1952	·202	·832	·281	1·113

In none of the five cases under consideration is the sum of the exponents a_1 and a_2 significantly different from 1, indicating the existence of constant returns to scale in Indian manufactures.

I am thankful to Dr. T. P. Chaudhuri and Dr. Des Raj for useful suggestions in this study.

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NEAR ULTRAVIOLET ABSORPTION SPECTRA OF CERTAIN SUBSTITUTED HETEROCYCLIC COMPOUNDS

THE absorption spectra of a number of substituted heterocyclic compounds in the vapour state have been photographed in the region λ3,000-2,250, using Hilger's Littrow, medium and small quartz spectrographs. The spectra have been studied by varying the length of the vapour column from 2 cm. to 100 cm., the temperature of the liquid container being varied from −15° C. to 90° C. For two of the compounds (2, 5-dimethyl furan and pyrrolidine) fairly intense and discrete absorption bands which are not previously recorded, have been observed. For 2-furfuraldehyde, a very rich and intense band system consisting of many more bands than were recorded by Purvis[1] has been obtained. In all these cases, the bands appear in groups, the components of which show some regularity. A qualitative study of the polarisation characteristics of the Raman lines of 2, 5 dimethyl furan and 2-furfuraldehyde has also been carried out while for pyrrolidine, the data regarding the depolarisation factors as determined by Kohlrausch[2] and Reitz, have been used. The location of the 0, 0 band is made from a study of the development of the spectrum at different temperatures and its appearance at the minimum vapour pressure conditions. The intensity of absorption and the analysis of the bands in each case indicated that the electronic transition giving rise to the spectrum is of an allowed type. The results are presented in Tables I and II. The ground state frequencies agree well with the Raman[3] lines in all the three cases and also with those obtained from the study of the infra-red absorption[4] in pyrrolidine.

TABLE I

Molecule and symmetry		Region of absorption in Å	$\nu_{0,0}$ band in cm.$^{-1}$
2-Furfuraldehyde	C_s	2800-2450	37107
2, 5-dimethyl furan	C_{2v}	2510-2250	40541
Pyrrolidine	C_s	2720-2454	38349

TABLE II

Frequencies in cm.$^{-1}$

2-Furfuraldehyde		2, 5-Dimethyl furan		Pyrrolidine	
Ground State	Excited State	Ground State	Excited State	Ground State	Excited State
204	..	265	..	230	175
290	202	..	..	..	..
..	380	606	442	597	429
616	446	..	492	865	675
742	561	..	645	..	889
878	742	..	..	..	..
..	883	..	954	1102	..
1149	1028	..	1244	1226	1063
1359	1284	..	..	..	..
..	1385	..	1532	..	1314
..	1478	..	..	..	..
..	2393	..	..	..	..
..	2927	..	..	..	..

The details of the interpretation of the bands and the assignment of the frequencies will be published elsewhere.

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EMISSION BANDS OF BENZONITRILE

In the course of our attempts to excite the emission spectra of polyatomic molecules it has been possible to obtain several emission bands in a h.f. discharge through flowing as well as stagnant vapour of benzonitrile. These bands lie between 2,680 and 2,925 A and have been photographed on a large quartz Hilger Littrow Spectrograph which has a dispersion of about 4 A/mm. in this region. The bands are all sharp and degraded towards longer waves. Forty of such bands have been measured with an accuracy of ± 3 wavenumbers. Fourteen of these agree in wavelengths with the absorption bands[1] of benzonitrile and all except a couple of them also agree fairly well with the data given by Bass[2] of the fluorescence bands of benzonitrile. The bands are therefore in all probability due to benzonitrile.

The spectrum consists of discrete bands superposed on a continuum. Fig. 1 is a reproduction of a typical spectrogram of the bands and on it is shown also the general analysis of the more prominent bands. The bands allow themselves to be regarded as due to an allowed transition, probably $B_1 \rightarrow A_1$, assuming C_{2v} symmetry. The strong band at 36,520 cm.$^{-1}$ is the zero band of the system, as is already known in fluorescence at 36,519 cm.$^{-1}$ and in absorption at 36,516 cm.$^{-1}$ A comparison with the fluorescence bands is given below.

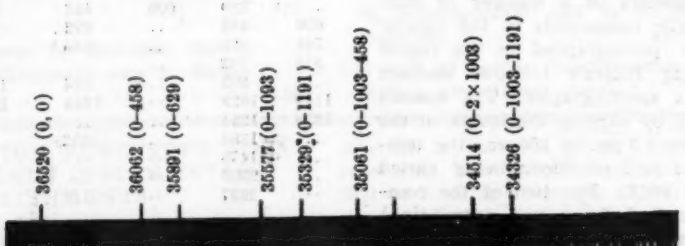

FIG. 1. Emission bands of benzonitrile in flowing vapour, photographed on large quartz Hilger Littrow Spectrograph. Slit-width 0·035 mm. Exposure time seven hours.

The relative intensities of the bands are, more or less, the same in both spectra except for one marked difference. In the fluorescence spectrum the zero band and its long wavelength companions are weak while here they appear with a much higher intensity. The fluorescence spectrum contains about 145 bands and has been interpreted in terms of twenty ground state frequencies whereas here only 40 bands are observed, involving eight ground state and three upper state frequencies. In the fluorescence spectrum no bands have been measured on the shorter wavelength side of the zero band, while here five weak bands appear in that region, which, except for one band, appear in absorption also.

In the emission spectrum there occur bands at 35,933, 34,889, 34,472, 34,432, 34,383 and 34,282 cm.$^{-1}$ which are not reported in fluorescence. The bands at 35,603 and 35,395 cm.$^{-1}$ which were left unassigned earlier, receive satisfactory assignments in the present studies. In the studies in fluorescence a large number of bands have two or more possible assignments. The emission spectrum has been helpful in choosing the more probable ones out of these.

There is good agreement in the values for the ground state frequencies obtained in the two methods except in two cases. The frequency 629 as measured here is in agreement with that obtained from Raman effect[1,3] (624) and from ultraviolet absorption bands[1] (626), but differs from what appears to be the same vibration of frequency 618 in fluorescence which however agrees better with the results obtained from infrared absorption[4] and ultraviolet absorption studies by Masaki[5] (616). Similarly the ground state frequency 670 as obtained here agrees well with that reported in ultraviolet absorption[1] (670) as compared with the value 681 reported in fluorescence. In fluorescence the prominent bands are accompanied by long

wavelength companions at separations of 15 and 40 cm.$^{-1}$, while here only the companions at separations of 41 cm.$^{-1}$ are seen to occur.

Details will be published elsewhere.

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NEW EMISSION SPECTRUM OF IODINE IN THE FAR AND VACUUM ULTRAVIOLET

THE electrical excitation of iodine vapour has been studied by the authors using two different sources—a condensed transformer discharge and a high frequency discharge from a high power oscillator (100 watts). Photographs of the spectra reveal a new emission spectrum of neutral iodine molecule, particularly in the region λ 2,500 to λ 1,300.

Pure iodine vapour was excited in an ordinary H-shaped discharge tube of internal diameter 20 mm. by passing a condensed discharge from a 20 KV transformer. Surrounding the intense green discharge due to the atomic line spectrum of iodine, a characteristic bluish violet emission was observed. This characteristic glow was photographed in the region from λ 6,500 to λ 1,950 using Glass Littrow instrument in the visible region and Hilger small and medium quartz spectrographs in the far and near ultraviolet regions. Below λ 1,950 down to λ 1,000, one meter normal incidence vacuum grating spectrograph having a dispersion of 17·3 A/mm. was employed. Eight discrete band systems in the region λ 6,500 to λ 1,950 as shown in Table I together with a number of semi-continuous bands at λ 4,745; 4,660; 4,575; 3,520; 3,480; 2,880; 2,865; 2,855; 2,845; 2,835; and 2,825 were observed. The visible band system λ 6,500-λ 5,000 is earlier known to occur in high frequency excitation of pure iodine vapour, and the four discrete band systems in the region λ 4,400 to λ 2,520 are known to occur in the fluorescence and electrical excitations of iodine vapour in the presence of nitrogen or argon.[1-3] Some of the semi-continuous bands are identified with those observed by Venkateswarulu,[3] using an uncondensed transformer discharge in the presence of argon. Below λ 2,500, our photographs reveal three new discrete band systems in the region up to λ 1,950 and thirteen systems in the region λ 1,950 to λ 1,460 as shown in Table I. These discrete band systems in the region λ 2,500 to λ 1,460 have been obtained for the first time in emission. Some of the bands belonging to the systems in the region λ 2,500 to λ 1,950 coincide with those reported by Pringshiem and Rosen[4] and Kimura and Miyanshi[5] in absorption. Below λ 1,950, some of the band systems in Table I have been reported earlier by Cordes[6] in absorption.

The spectrum of iodine vapour excited by a high power high frequency oscillator was found to be quite similar to the one obtained in the condensed transformer discharge in the region λ 2,230 to λ 1,300. All the band systems mentioned previously in this region are clearly obtained. The prominent system extending between λ 1,950 to λ 1,790 is found to consist of about 200 band heads as against only 90 bands reported by Cordes in absorption. The spectrum in the region λ 6,500 to λ 2,400 consists of only one discrete band system in the visible region, and a number of diffuse bands in the region λ 4,800 to λ 2,400 which were reported and interpreted by Venkateswarulu.

Recently, Venkateswarulu[3] has reported the analyses of the four band systems in the region λ 4,400 to λ 2,520 and interpreted them in terms of the well-established term scheme of the neutral iodine molecule. Our present emission pictures revealed the existence of three new band systems in the region λ 2,500 to λ 1,950. For two of these which are well developed, the vibrational constants are given in Table I. In addition to the extensive system lying between λ 1,950-λ 1,790, analysed and interpreted by Venkateswarulu, Cordes has identified seven brief band systems in the region λ 1,790 to λ 1,540. He explained six of these systems as due to the transitions from the ground state to various upper states. The positions of these levels, however, are uncertain as there is considerable overlapping of these systems in this region. For identifying the number of systems and the positions of the levels involved, a close study of the emission spectrum in this region is more desirable. Our emission pictures reveal clearly the existence of twelve brief systems in the region λ 1,790 to λ 1,460. For all of these except two, the positions of the upper levels ($\sim \nu_{0,0}$) and the aproximate vibrational frequencies are given in Table I.

TABLE I

Discrete band systems due to stable electronic levels in the neutral iodine molecule

No.	Extent of the region of the spectrum in Å	Vibrational frequencies ω_e'	ω_e''	System origin ν_e cm.$^{-1}$
1	9300–8375	44·0	213·8	11803
2	6700–5000	126·6	213·8	15598
3	4420–4000	101·9	126·6	25757
4	3455–3015	103·0	213·8	39131
5	2785–2750	104·5	213·8	45781
6	2730–2520	96·2	213·8	47150
7*	2500–2400	..	..	..
8*	2415–2240	93·4	213·8	45230
9*	2230–1950	79·0	213·8	48072
10	1950–1790	165	213·8	51683
11*	1785–1740	223	213·8	56754
12	1780–1725	210	213·8	56930
13	1750–1700	236	213·8	57794
14*	1715–1680	240	213·8	58875
15	1710–1670	206	213·8	59254
16*	1670–1645	103	213·8	60686
17*	1640–1620	110	213·8	61335
18*	1615–1585	170	213·8	62586
19*	1595–1560	240	213·8	63458
20	1570–1540	130	213·8	64317
21*	1545–1500	170	213·8	65776
22*	1490–1460	134	213·8	67099

The systems marked with (*) are newly identified and analysed in the present work.

System 7 is not well developed. System 10 was recorded by Cordes in absorption and analysed by Venkateswarulu. Systems 12, 13, 15, 18 and 21 were obtained and analysed by Cordes in absorption. Some more additional bands belonging to these systems were obtained by us in emission.

Full details of analyses of all the systems newly obtained and analysed in the present work, and a complete discussion on the nature of the electronic states of the neutral iodine molecule in terms of electron configurations will be published shortly.

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VARIATION OF THE NUMBER OF ISOTOPES AND ISOBARS IN ALPHA AND BETA DECAY

AT present there are several alpha decay chains of artificially produced radioactive nuclides.[1–3] Most of these isotopes and isobars for alpha decay are from Pt (Z = 78) to Cm (Z = 96) as given by Pryce.[4] Cases of isotopes and isobars from elements of atomic number 80 to 96 that take part in alpha decay have been considered. Cases of beta decay within the same range have also been considered for the sake of comparison. The data on such isotopes and isobars was taken from Feingold.[5]

Graphs have been plotted between atomic number (Z) and the number of isotopes (Fig. 1), and between mass number (A) and

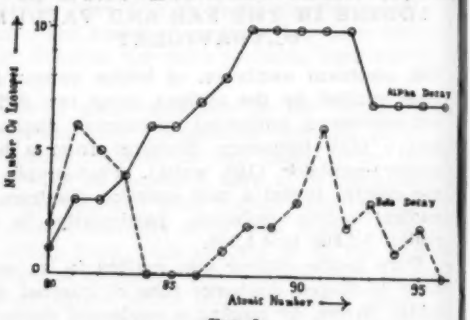

FIG. 1

the number of isobars (Fig. 2) for alpha and beta decay.

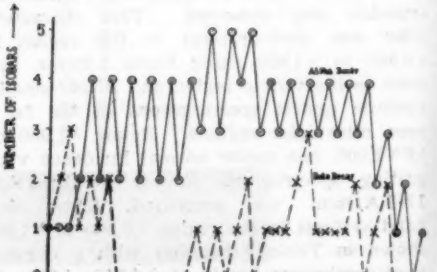

FIG. 2

(*a*) *Isotopes.*—For alpha decay, the number of isotopes is minimum for Z = 80. It goes on increasing for higher atomic numbers until a constant value is attained from 88 to 92. After 92 it again falls down but remains constant after 93. For beta decay, the graph shows periodic fluctuations of maxima and minima. Maxima of six is attained at Z = 81 and 91.

A flat minimum occurs for 84, 85 and 86. Another minimum is at 96.

The alpha and beta curves roughly vary in the same manner. The number of isotopes for alpha decay is more than the corresponding number for beta decay for any atomic number from 84 onwards. Also for beta decay maxima and minima are observed at almost regular intervals.

(*b*) *Isobars.*—In the case of alpha decay, the number of isobars is smallest at A = 210. Then it rises and goes through maximum and minimum values till the end. The maximum value is attained at A = 224, 226 and 228. This also shows that the number of isobars is generally always high for even mass numbers and low for odd ones, which is very interesting.

For beta decay, the maxima and minima are also observed at somewhat regular intervals. The first maximum occurs at 210 and second maximum at 234. Also the number of isobars for a particular mass number is always more in the case of alpha decay than the corresponding case of beta decay.

The increase of the number of isotopes and isobars in alpha and beta decay for heavier elements is due to their reduced stability. The periodic table ends after Z = 96, because of the increasingly negative values of the binding energies for alpha emission and fission.

But the periodic fluctuations of the number of isotopes and isobars in beta decay and the increase of number of isobars for even mass numbers and decrease of the same for odd ones in the case of alpha decay cannot be explained on the basis of recent theories. This also shows that the elements of even mass numbers are less stable than those of odd ones in the case of alpha decay. These facts have passed unnoticed, so far. The various theories regarding alpha and beta decay have to be suitably modified to account for these important observations, which may throw more light on nuclear structure.

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THE RAMAN SPECTRUM OF *p*-TOLYL ISOTHIOCYANATE

The Raman spectrum of p-tolyl isothiocyanate has been recorded earlier by Dadieu.[1] Using a Hilger Raman Source Unit and a Fuess glass spectrograph having a dispersion of 19 cm.$^{-1}$ per mm. in the λ 4,358 region, the authors have recorded in 25 minutes, an intense Raman spectrum of this cyanate, which shows eight new frequencies and a band at 2,015 cm.$^{-1}$ of about 110 cm.$^{-1}$ width. The results are given below with the usual conventions.

338(3), 397(0), 500(1), 595(0), 650(7), 693(½), 742(½), 786(5), 874(½), 925(½), 1,016(1), 1,066(0), 1,114(1), 1,141(1), 1,170(9); 1,205(1), 1,241(10), 1,276(1), 1,298(1), 1,370(2); 1,430(½), 1,498(7), 1,575(1), 1,604(10), 2,015-2,128(3 *b*), 2,174(2), 2,923(3), 3,070(2).

Three lines at 1,298, 1,575 and 1,430 cm.$^{-1}$ appear respectively to be the overtones and the summation tone of the fundamentals of the C = S vibrations at 650 cm.$^{-1}$ and 786 cm.$^{-1}$ Regarding the intense line at 1,241 cm.$^{-1}$, the authors propose to ascribe it to the C-N bond formed by the carbon of the ring and the nitrogen of the thiocyanate. On the basis of the infra-red data for aromatic amines, Colthup[2] has assigned the strong absorption bands in the region of 1,250-1,340 cm.$^{-1}$ to the C-N bond. A comparison between the frequencies of the > C-O in aromatic esters at 1,270 cm.$^{-1}$ as proposed by one of the authors[3] and the frequency of > C-N = bond at 1,241 cm.$^{-1}$ in the present case, indicates a confirmation of the proposed assignment of 1,241 cm.$^{-1}$ to the > C-N vibrations in the isothiocyanate. Further a comparison of the frequencies of p-tolyl isothiocyanate (H_3C N = C = S) with those of the simpler molecules such as toluene (H_3C), phenyl hydrazine ($NH.NH_2$) and aniline (NH_2), reveals significantly that with the removal of the — N = group from the molecule, such as in toluene, the line of comparable intensity in the region 1,250 cm.$^{-1}$ disappears.

Another interesting point arises out of two lines at 1,114 and 1,141 cm.$^{-1}$ missed by Dadieu. Both these lines cannot be explained as being the overtones or the combination tones of the fundamentals. The lines 338 and 786 cm.$^{-1}$ can, however, give rise to a summation tone at 1,124 cm.$^{-1}$, which happens to be the mean of 1,114 and 1,141 cm.$^{-1}$ Probably this is a case of Fermi Resonance, which results in the line

at 1,124 cm.$^{-1}$ splitting into two lines of equal intensities.

The authors thank Professor S. Bhagavantam for his guidance and acknowledge with thanks the pure sample of the compound made available to them by Dr. V. R. Srinivasan of the Department of Chemistry, Osmania University.

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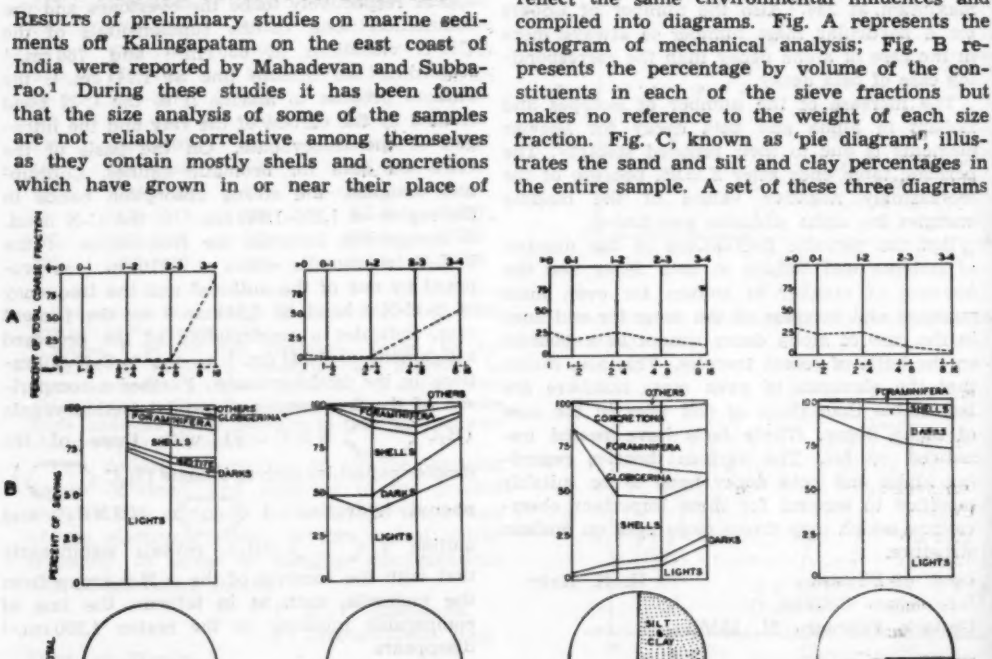
SEDIMENTARY ENVIRONMENTS OFF KALINGAPATAM-GOPALPUR COAST BY COARSE-FRACTION STUDIES

RESULTS of preliminary studies on marine sediments off Kalingapatam on the east coast of India were reported by Mahadevan and Subbarao.[1] During these studies it has been found that the size analysis of some of the samples are not reliably correlative among themselves as they contain mostly shells and concretions which have grown in or near their place of deposition and as such are not strongly influenced by transporting agents such as currents and waves. These sediments are, therefore, further subjected to 'coarse-fraction analysis', a method adapted by Shepard and Moore[2,3] in the study of Central Texas marine sediments and by Wimberley[4] for investigating the sediments north of La Jolla Submarine canyon, California.

In the coarse-fraction method, about 50 g. of oven-dried sample are soaked overnight in a dispersing solution of sodium hexa-meta phosphate and is then wet-sieved through a 0·066 mm. (Endecott Mesh No. 240) screen to separate the sand size fraction from silt and clay. The coarse-fraction is dried and sieved in a Rotap to the (approximate) Wentworth size grades. A representative split from each of the sieving is studied under the binocular microscope and percentages by volume of significant constituents such as shells, terrigenous minerals, etc., are estimated. The results are averaged for groups of samples that appear to reflect the same environmental influences and compiled into diagrams. Fig. A represents the histogram of mechanical analysis; Fig. B represents the percentage by volume of the constituents in each of the sieve fractions but makes no reference to the weight of each size fraction. Fig. C, known as 'pie diagram', illustrates the sand and silt and clay percentages in the entire sample. A set of these three diagrams will depict a complete environmental picture of the sediment.



FIGS. A–C

cluding black opaques, garnet, biotite, etc., shells, benthonic foraminifera, pelagic foraminifera and concretions were the constituents considered significant and diagnostic in the area for the purposes of estimations. Others such as plant fibres, rock fragments, etc., were also considered.

The inner-shelf environment, extending from depths of about 5 fathoms out to 20 fathoms, is characterised by (*i*) absence of coarse sand, (*ii*) abundance of biotite among the dark minerals, especially opposite Vamsadhara confluence, (*iii*) large percentages of terrigenous minerals, and (*iv*) minor amounts of shells and foraminifera. The sediments from this environment are highly well-sorted in the 1/8-1/16 mm. size grade.

Sediments of the outer-shelf environment extending from depths of 40 fathoms down to 100 fathoms are characterised by preponderance of shells, foraminifera and concretions. Terrigenous minerals increase in quantity in the finer size grades. Pelagic foraminifera (globigerina type) and concretions essentially of calcium carbonate[5] in appreciable amounts are most characteristic of this environment. In contrast to the inner-shelf sediments these show very poor sorting of their constituents.

Towards the north of the area under investigation the outermost shelf beyond the depth of 60 fathoms consists only of plastic grey-coloured muds (not illustrated).

The part of the shelf lying between the depths of 20-40 fathoms (the inner-outer shelf transition zone), constitutes a distinct depositional environment. The sediments from this environment differ from those of the inner shelf in having larger percentage of shells and significant amounts of coarse sand. Further, unlike the outer-shelf sediments these contain terrigenous minerals predominating over others. Unusual occurrence of sand somewhat coarser in association with clays and silts in these depths all along the eastern coast was reported by Poornachandra Rao.[5]

In such a general dispositional pattern of the environments occur two very coarse sandy patches possessing characteristics altogether different from those of the above. These sands contain small quantities of silt and clay. Shells, though present, are not significant. They contain, on the other hand, large amounts of dark minerals.

In general, in Kalingapatam area, there is a seaward progression of the constituents of the coarse-fraction, shells increasing outward while sand content decreasing. The environments as revealed by these studies fit into the zonal delineation made on the basis of calcium carbonate content and grain size distribution of the sediments.[1]

Full details will be published elsewhere.

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SOME CYTOPLASMIC DETAILS OF YEAST REVEALED BY THE ELECTRON MICROSCOPE

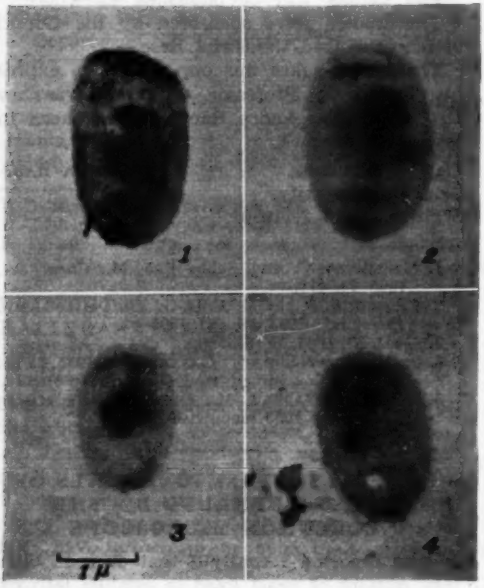
It was reported recently[1,2] that even in ultra-thin sections of yeast fixed in osmium tetroxide structural details could not be made out owing to the cytoplasm being impenetrable to the electron beam. Bartholomew and Mittwer[3] used ultra-violet photolytic methods to obtain electron micrographs of the internal structure.

In bacteria the cytoplasm has a strong affinity for basic dyes resulting in difficulties in demonstration of the chromatinic structures. This practical difficulty was overcome by mild hydrolysis.[4] Hydrolysis of yeast cells was therefore carried out to discover whether such a treatment would make the cytoplasm transparent to an electron beam.

The strain of yeast used was the riboflavin excreting mutant, BY 2.[5] Young cells from wort cultures at 28° C. fixed in 40% neutral formaldehyde for 1 hour and stored in 5% formaldehyde for 3 days were washed for 3 hours in repeated changes of distilled-water and hydrolysed in N HCl for 12-15 minutes. Small droplets of distilled-water suspension of cells were transferred to supporting membranes of Formvar on specimen carriers, dried and examined with a Philips three-stage electron microscope operating at 60 KV. The cells were viewed on the fluorescent screen at 10,000 diameters and photographed at a quarter of that magnifi-

cation on Kodak 35 mm. safety positive film. The negatives were enlarged six times.

The progressive removal of opacity could be seen in Figs. 1, 2, 3 & 4. The removal is not



FIGS. 1–4

uniform but in patches. Attention is invited to the spherical electron opaque body in Fig. 3 which reminds one of the nucleus described from stained preparations. While the impenetrability of the cytoplasm to the electron beam makes a study of all the cell organelles difficult, the fact that hydrolysis removes the opacity offers the hope that investigation of the nucleus and its behaviour during cell division may be possible.

We are thankful to Dr. M. K. Subramaniam for his encouragement.

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DIGESTIVE ENZYMES OF *MARTESIA STRIATA* LINN.

EVEN though much work has been done on the digestive enzymes of bivalve molluscs by a number of workers,[1–7] very little is known about the digestive enzymes of wood-boring molluscs. Harrington[8] and Boynton and Miller[9] detected amylase and cellulase in the digestive diverticula of *Teredo* and *Bankia*. Nair[10] studied the digestive enzymes of *Bankia indica*. However, no work has been done on the digestive enzymes of *Martesia striata*, which is an important wood-boring bivalve in tropical waters.

The present note describes the results of experiments to determine the nature and action of the digestive enzymes of *Martesia striata*, the common wood-borer, destroying wooden jetties in Visakhapatnam Harbour. Extracts of the digestive diverticula and crystalline style were made as per standard methods.[11] The activity of the enzymes on carbohydrates was determined by methods used by Yonge[12] and Somogyi.[13] The products of fat digestion were estimated by the direct titration of the fatty acid formed with sodium hydroxide solution using phenolphthalein as the indicator and products of protein digestion by Sörenson's formol titration method. In the enzymic experiments the pH of the medium was controlled by suitable buffers, namely, Sörenson's M/15 phosphate buffer pH 5·3 to 7·7 for carbohydrates, M/10 citric acid, M/5 sodium phosphate buffer of McIlvaine, pH 3 to 6·6 followed by 0·2 N phosphate-sodium hydroxide buffer of Britton and Welford pH 6·6 to 12·2 for protein and the method adopted by Nicol[14] for fat digestion. The temperature was maintained by an electrically controlled thermostat.

The results of these experiments showed that the digestive system of *Martesia striata* is effective on carbohydrates, fats and proteins. The digestive diverticula were found to contain a strong enzyme system which can hydrolyse a variety of carbohydrates like maltose, sucrose, lactose, raffinose, starch and glycogen but not regenerated filter-paper, sawdust and cotton-wool. The activity-pH curve when plotted for the action of amylotylic enzyme showed that the digestive activity is at its maximum at pH 5·9. A series of experiments to determine the relation between optimum pH and duration of experiment showed that the pH at which digestion is optimum is not changed when the period of incubation is continued from 8, 16, 24 and 32 hours. The temperature of destruction for amylase is found to be between 65° C.

and 70° C. Similar experiments with extracts of crystalline style showed the presence of a strong amylase (optimum pH 5·5), maltase and lactase but not cellulase. Style amylase is also found to be destroyed between 65-70° C.

The lopoclastic enzymes present in the digestive diverticula of *Martesia* though weak, are able to act on methyl acetate, amyl acetate, olive oil and lecithin. The optimum pH of the lipase is found to be 7·6 and the enzyme is destroyed at about 70° C. The protease, just as in other bivalves, is very weak but is capable of acting on different types of proteins like gelatin, fibrin, casein and peptone. The results of experiments with peptone as substrate showed that the protease possesses two optimal pH values, pH 4·0 and 8·5, and it is completely destroyed at 70° C.

The absence of cellulase both in the digestive diverticula and crystalline style is significant as it confirms the idea that *Martesia striata* bores into the wood for the sake of shelter alone and has not the capacity to digest the wood, unlike the shipworms, *Teredo* and *Bankia*.

A full account will be published elsewhere. This work has been carried out with funds provided by the Forest Research Institute, Dehra Dun, specially obtained from various sources for the execution of the scheme on the protection of timber against marine-boring organisms attack.

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TWO FUNGAL INFECTIONS OF *HEVEA* SEEDS

SEVERAL consignments of *Hevea* rubber seeds, imported last year from Malaya by planters in South India, were examined at the Plant Quarantine Station, Madras. Occasionally, pycnidia of *Botryodiplodia theobromæ* Pat. and *Phomopsis heveæ* (Petch) Bœdijn were noticed on the seed-coat, in or near the region of the micropyle and hilum or along the raphe. *P. heveæ* was also often observed on rubber leaves entrapped in the packing material. Both fungi have hitherto not been described on the seeds, though a rapid deterioration of seeds in Sumatra, was once[2] ascribed to the former fungus.

Pycnidia of *B. theobromæ* were large, markedly erumpent, dark brown or black, separate or grouped together. In the consignments examined here, often about 10% of the seeds were found to be affected by a rot attributable to the fungus, which was isolated from diseased seeds, in pure cultures, on several occasions.

Pycnidia of *P. heveæ* were minute, scattered, dark, more or less globose and erumpent. Usually, both 'A' and 'B' spores were present, hyaline and unicellular, the former short, more or less elliptical, and the latter long, slender, mostly uncinate, and measured 6-10 × 2-2·5 μ and 16-30 × 1-2 μ respectively. This fungus was earlier reported only on dead rubber branches from Sumatra[1] and Ceylon,[3] but is also said to incite dieback in young seedlings in Java.[4]

Spores of *B. theobromæ* and 'A' spores of *P. heveæ*, from pycnidia on the seeds, germinated in ordinary distilled water at about 25° C., within 2-4 and 20 hours respectively. If the seeds were lightly sprayed with commercial formalin, diluted with an equal amount of water, in a fine mist, and kept covered for 4 hours followed by thorough aeration, no germination of spores was observed even after 48 hours. Preliminary trials indicated that the viability of healthy seeds was not adversely affected by this treatment.

Under the existing regulations of the Destructive Insects and Pests Act of 1914, import of *Hevea* seeds into India is prohibited from America or West Indies except by the Director of Agriculture, Madras, while from other countries it is permitted after inspection and, if necessary, treatment at the port of entry. The consignments of *Hevea* seeds from Malaya, referred to herein, were thoroughly cleaned of all leaves and other plant debris, and later given the formaldehyde treatment, indicated above,

prior to release. Nevertheless, it is desirable that the plants raised from all such imported seed be subject to post-entry inspection and outbreak of any disease promptly dealt with.

The author is grateful to Shri K. N. Kaimal, Rubber Production Commissioner, for kindly confirming the identity of rubber leaves, and to Dr. P. R. Mehta of this Directorate, for helpful suggestions in the preparation of the manuscript.

Directorate of Plant Protection, Quarantine and Storage, Plant Quarantine Station, Madras-1, *January* 7, 1955. S. N. S. SRIVASTAVA.

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BENTHIC ORGANISMS OF A FRESH-WATER FISH-TANK

IN the course of investigations on the bottom-fauna of fresh-water bodies, which constitute the chief food of the carnivorous bottom feeding fishes, there was noticed a marked variation in its composition during different periods of the year, both qualitatively and quantitatively. The investigations in related fields of the subject made by Bristow,[1] Samuel,[2] and Seshappa[3] are mainly limited to marine regions. No doubt Hora[4] studied the nature of substratum as an important factor in the ecology of the torrential fauna, and Srivastava[5] gave some observations on the subject, but to my knowledge no detailed qualitative and quantitative data on fresh-water benthic organisms, are available for India in general and Uttar Pradesh in particular.

In order to secure data necessary for the study of benthic fauna, regular weekly collections were made with the help of a simple scoop type bottom sampler. Each sample was later fractionated by means of a modified Lea-Gibbon's subsampler, and only one-tenth of the collection was taken and passed through graded sieves, the excess of water being allowed to pass out. The organisms were finally collected from each of the seives and qualitative and quantitative estimations made.

The bottom of the fish-tank under examination consisted mainly of soft mud mixed with fine sand. The atmospheric temperature along with the temperature of the water, brought remarkable changes in the total volume and the percentage composition of the bottom organisms. During monsoon the water registered a high level, but it experienced a gradual decline in winter, till finally it reached the minimum level in summer and a long strip of the bottom was left exposed to air and sun, which brought a large-scale mortality in a majority of the benthic fauna. In the next monsoon season, the water-level registered an increase due to the rains and local drainage of the water, and the exposed strip was again submerged.

The quantitative data reveal that the total volume of bottom fauna was highest during the monsoon months. This peak was mainly due to the abundance of molluscs and oligochætes. After this monsoon peak there was a fall in total volume, till it reached the minimum level in winter months (Fig. 1). How-

FIG. 1

ever, in spring the volume experienced an increase again due to the abundance of oligochætes. During summer months there was a decline in the total volume of the bottom samples, which was still further lowered due to exposure to air and hot sun.

It has been observed that fresh-water oligochætes (*Dero, Nais, Chætogaster*, and *Aeolosoma*) constituted the main bulk of the samples during the year, but there was a general increase during the monsoon and summer months (Fig. 2). *Chironomous* larvæ although present throughout the year, were found in

largest numbers during winter months. Large gastropods and bivalves were almost uniformly represented, but their percentage was reduced during winter season. Small snails (*Planorbis*)

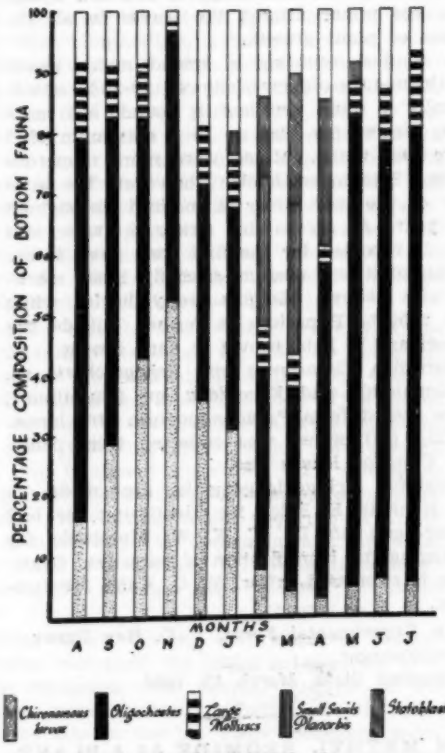

FIG. 2
Unshaded portion–*Miscellaneous*

were however present in good numbers in winter, while nymphs of dragonflies were also common. A few leeches were also represented during the year. Ostracods and some aquatic insects were collected from samples throughout the year.

It is quite evident from the observations recorded above that the benthic fauna was quantitatively lowest during winter months and highest during the monsoon. Unlike the plankton, which has two peaks,[6] the bottom fauna has only one peak during the year. Investigations on the ecology of this large assemblage of burrowers, clingers, crawlers and hiders among bottom materials, are being continued and fuller results will be published later. The present results have important correlation with the food of bottom feeding fishes of Uttar Pradesh[7] which are being investigated separately.

I am grateful to Dr. S. M. Das for valuable guidance during the conduct of the work.

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USE OF ORGANO-MERCURIAL FUNGICIDE AS SETT TREATMENT FOR SUGARCANE

THE use of *Aretan*, an organo-mercurial fungicide, has been reported by Mc. Martin[1,2] to afford protection to sugarcane setts from pineapple disease, as also for improving the rate and extent of germination under dry soil conditions in South Africa even when the disease did not exist. This was attributed to a prevention of the ingress of soil micro-organisms through the cut ends which constituted a drain on the moisture and nutrient reserves of the sett and caused production of toxins as a result of fermentation. Similar results were obtained in Mauritius,[3] Queensland[4] and Louisiana.[5] Under North Indian conditions, lack of soil moisture is a factor seriously retarding germination and these studies were accordingly undertaken with a view to exploring the possibilities of *Aretan* in this connection.

The trials were laid out on a field scale in three replications at Pusa in North Bihar (light calcareous loam), the treatments involving three concentrations of the chemical (1, 2 and 4 oz. per 10 gallons) each under five durations of soaking, *viz.*, dip in and out and soaking for 15, 30, 45 and 60 minutes. A parallel series was run with water instead of *Aretan* solutions along with "no treatment" as control. The results showed: (*i*) All treatments improved per cent. germination significantly as compared to control. (*ii*) The highest figure of 36·1% was obtained under dip in and out treatment with 4 oz. concentration of *Aretan* followed by 15 minutes' soaking at the same concentration (34·3%) as against 14·8% in control. (*iii*) The period of soaking needed for greatest improvement in germination tended to decrease with increase in concentration of the fungicide.

(*iv*) In contrast to the above, the rate of germination under control was superior to all treatments and significantly so in most cases. (*v*) Growth, yield and juice quality data did not show any significant or systematic differences.

It would thus appear that considerably improved germination results from use of *Aretan*, the best performance being recorded with dip in and out treatment in a solution containing 4 oz. of the chemical in 10 gallons water. Further work is in progress.

The work forms part of the Sugarcane Research Scheme in Bihar being financed jointly by the Government of Bihar and the Indian Central Sugarcane Committee to whom grateful thanks are due.

Central Sugarcane Res. Station, Pusa (Bihar), *October* 30, 1955. M. S. SUBBA RAO. N. S. NEGI. K. L. KHANNA.

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PSEUDONAPOMYZA ATRA ON MAIZE LEAVES

MAIZE leaves were mined by the maggots of *Pseudonapomyza atra* (Meigen), (Phytomyzinæ, Agromyzidæ) at Himayatsagar Farm during 1952. Since then the fly has been noted throughout the Hyderabad State. The mines are usually linear, measuring from 2 to 10 cm. long and 1 to 1·5 cm. wide. Sometimes the mines coalesce and form a blotch and become wider. When fresh, the mines appear light green, but on drying become brown and finally white. If the attack is in the early stage of the crop, the severely mined leaves may dry up and drop off the plant.

Maggots are solitary miners but more than one maggot per mine was noticed, and in a few cases 5 maggots were found in a single mine. The yellowish white maggots mine between the epidermal layers of the leaf. If a mine is held to light, the extent of mine and the maggot inside can easily be seen. Generally the maggot works from the tip of the leaf toward the base, although mining from base toward apex is seen in a very few cases.

Frass was found scattered in the mine. No puparia were found in the tunnel nor on the leaves. Before pupation, mature maggots cut slits in the tunnel and come out for pupation in the soil. Sometimes black specks are found in the mines which can be mistaken for puparia; on examination, however, it will be found that these are parasitized maggots and are dying. The leaf miner attacks the leaves in all the stages of plant growth.

A random counting of mined maize leaves of 1½-months-old crop showed 10-30% attack. Usually 1 mine per leaf is found, but more than 1 mine per leaf up to a maximum of 5 were also noted. Mines were more numerous during September-October, however, the activity of the leaf miner is noticed throughout the year. As far as this writer is aware, this pest is reported for the first time from India.

The adult is a medium-sized fly, black marked with yellow. Maggots are yellowish white and robust. Puparium is formed outside the tunnel and is light brown to dark brown.

Parasites, *Derostenus* sp., *Achrysocharis* sp. (Eulophidæ), and *Eucoilidea* sp. (Eucoilinæ), were reared from *Pseudonapomyza atra* larvæ.

This leaf miner was collected from paddy and *Cynodon* leaves also.

Grateful acknowledgements are made to Dr. Kenneth E. Frick for identifying the leaf miner and to Dr. C. F. W. Muesbeck for arranging the identification of parasites. Gratitude is expressed to Dr. M. Q. Kahn for facilities.

Main Experimental Farm, Rajendranagar, Hyderabad State, *March* 13, 1956. D. BAP REDDY.

ON METHYL BROMIDE AS A PLANT FUMIGANT

METHYL BROMIDE (bromo-methane—CH_3Br) has been officially recognised in America as an effective insecticidal fumigant. Because of its remarkable penetrating qualities, it is used in flour mills, warehouses, ships, goods wagons, etc.[1,2] It is also employed for the treatment of non-foliated plant materials such as corms, tubers, bulbs, fruits, etc.[1] It is, however, not recommended for fumigating green-house plants although certain herbaceous types as ferns, etc., were "successfully put under its influence".[3] English and Turnipseed[4] studied the reaction of the various kinds of nursery stock to methyl bromide and have recorded that certain plants were partially or completely defoliated but not killed by the chemical, whereas certain others were seriously injured by its effect. No grass or a monocot seems to have come under their study (also *vide* Anon[5]).

In conformity with the recommended procedure for plant quarantines in this country, cuttings of *Saccharum spontaneum* imported from abroad were subjected to fumigation with methyl bromide at a concentration of 25 c.c. of the liquid per 50 c. ft. of space for 1½ hours at room temperature, followed by hot water treatment at 52° C. for 20 minutes before planting in the quarantine shed. The buds of the cuttings thus treated germinated more or less normally, but the sprouts subsequently began to dry up. An examination showed that the death and drying up of the sprouts was due to the failure of the cuttings to root properly. All the root primordia had blackened, and such of the roots as had been formed had also died off. Some valuable material imported from foreign countries was thus lost.

As the material had received more than one phytosanitary treatment, in order to locate the cause of the destruction of the root eyes, a small experiment was conducted. Cuttings of six variants of *S. spontaneum* were subjected to the following pre-planting treatments: (1) no treatment (control); (2) fumigation with methyl bromide at the concentration given above; (3) soaking in hot water at 52° C. for 20 minutes; and (4) fumigation and hot water treatment as in (2) and (3). After these treatments, the cuttings were planted in sterile soil.

Observations showed that wherever methyl bromide was used, the initial germination, sett-root formation, and normal growth of the sprouts were adversely affected. In the control, as also in the hot water treatment without fumigation, germination and rooting were normal.

Varieties differed a little in the extent of their susceptibility to methyl bromide; in two varieties rootlets were formed before the effect of the fumigant set in; in four, the root eyes themselves were killed off. In the case of two variants, germination of buds was also completely arrested.

It appears from this that at least so far as *S. spontaneum* is concerned, serious damage is caused by the use of methyl bromide. It seems advisable, therefore, to exercise great caution in the treatment of grass-stalks with this fumigant.

We are grateful to Shri R. R. Panje for encouragement and guidance, and to Shri R. A. Agarwal and Shri K. V. Srinivasan for help in giving the treatments.

Sugarcane Breeding Inst., Lawley Road, Coimbatore, *March 7, 1956.*

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CYTOLOGY OF THE OPHIOGLOSSACEAE

From a critical study of over a dozen tropical species of *Ophioglossum*, one of *Botrychium* and the monotypic *Helminthostachys*, it has been possible to arrive at important findings regarding the cytology of the Ophioglossaceæ. The results of this study are reported in detail elsewhere. The purpose of the present note is to establish the lowest haploid number in the genus *Ophioglossum* and to postulate the probable basic number of the Ophioglossaceæ.

O. costatum R. br. (*O. fibrosum* Schum.).—Cytological examination of spore mother cells of this species collected from Palghat showed the presence of 120 bivalents at metaphase of meiosis (Fig. 1). Identical results have been

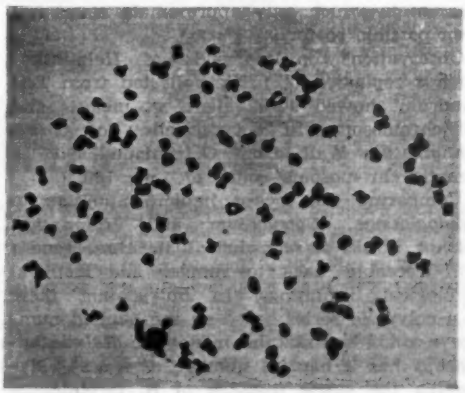

Fig. 1. Metaphase of first meiotic division in a spore mother cell of *Ophioglossum costatum* R. br. $n=120$ ×750.

obtained from three other species of *Ophioglossum* collected from different places in India.

O. lusitanicum L. (Locality, Tambaram).—This plant showed exactly 240 bivalents at meiosis (Fig. 2). Clear counts of 240 bivalents

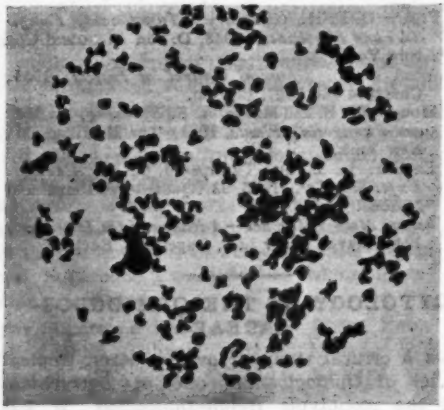

FIG. 2. Similar stage in *O. lusitanicum* L. $n = 240$, × 750.

were also obtained from several varieties of *O. nudicaule* obtained from different localities.

Previous reports of chromosome numbers in this genus indicate the presence of $n = 125 - 130$ in *O. lusitanicum* and $n = 250 - 260$ in *O. vulgatum*.[1] The present observations clearly show that the lowest haploid number in the Indian species is exactly $n = 120$. In the light of this finding, it seems desirable to re-examine with more abundant material other species of *Ophioglossum* in which only approximate count has been possible so far.

Observations on materials of *Helminthostachys zeylanica* (L.) Hk. collected from Trivandrum showed 94 bivalents at meiosis and 188 chromosomes in root tip cells. *Botrychium lanuginosum* Wall. from Ootacamund gave a somatic chromosome count of $2n = 180$.

Comparing the lowest haploid numbers in *Ophioglossum*, *Botrychium* and *Helminthostachys*, it will be seen that all the three genera are traceable back to simpler and identical cytological beginnings. In *Botrychium* there is a polyploid series based on the haploid number $n = 45$,[1-3] while the monotypic *Helminthostachys* has a haploid number of $n = 94$. Excepting the single instance of *B. virginianum* with $n = 91$ or 92[3] and *Helminthostachys*, the above-mentioned species of *Ophioglossum* and all species of *Botrychium* are seen to centre round a basic number of 15. Britton's observation of the existence of aneuploidy in the American *B. virginianum* (Muhl.) Fern. lends support to the possibility that in *Helminthostachys* also aneuploidy at an earlier stage might have given rise to a number which is slightly higher than a multiple of 15. It therefore seems plausible that in spite of the apparent discrepancy in chromosome number, *Helminthostachys* also with *Botrychium* and *Ophioglossum* shares the basic number of 15; and while the two former genera have become stabilised at comparatively low levels of polyploidy, the latter has succeeded in attaining very high levels of polyploidy, up to the sporophytic number of $2n = 1,260$,[4] the highest chromosome number yet reported in any species.

The author is indebted to Prof. A. Abraham for guidance and encouragement.

Dept. of Botany, C. A. NINAN.
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DEVELOPMENT OF ENDOSPERM AND NUCELLAR POLYEMBRYONY IN *AEGLE MARMELOS* CORREA

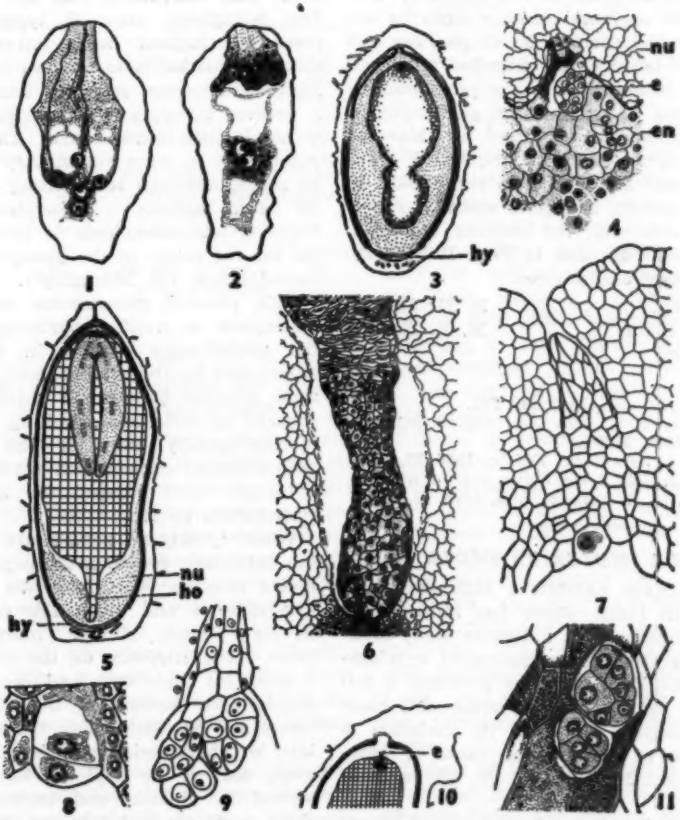
CHAKRAVARTHY[3] reported in this journal that "nucellar embryos are very rarely found in *Aegle* and even then they seem to stop development at a very early stage....." Out of a large number of young seeds examined by him, only two cases of nucellar embryos were noticed. Since our observations do not support this, a brief account of the endosperm and embryos is presented below.

There are nearly 200 ovules in the ovary but approximately 75% contain degenerated gametophytes. In most of the remaining embryo-sacs. the antipodal cells disorganize first (Fig. 1) followed by the egg apparatus, so that only the polar nuclei remain in a healthy condition (Fig. 2). Syngamy has not been observed, and even before the entry of the pollen tube the egg is usually in a degenerated condition. However, triple fusion probably occurs normally.

The endosperm is Nuclear. When approximately 256 endosperm nuclei have been formed, some of them aggregate at the chalazal end of the embryo-sac. Centripetal wall formation is initiated at the micropylar end and pro-

gresses downwards (Figs. 3, 4). An interesting feature is the development of an elongated chalazal process which digests the surrounding tissue (Figs. 5, 6). Mauritzon[4] observed a similar tubular projection in *Empleurum serrulatum, Coleonema album, Ptelea trifoliata* and *Triphasia aurantiola.*

oblique division (Fig. 8). Subsequent divisions are irregular resulting in the formation of an embryonal mass which projects into the cavity of the gametophyte where it undergoes further development. As many as three such masses, at different stages of development, have been observed in a single embryo-sac



FIGS. 1–11. *e*, nucellar embryo; *en*, endosperm; *ho*, chalazal process; *hy*, hypostase; *nu*, nucellus; the cross-hatched region in Figs. 3, 5 and 10 represents the cellular endosperm. Fig. 1. Embryo-sac with egg-like synergids and polar nuclei; the antipodals have degenerated, × 500. Fig. 2. Same, only the polar nuclei are healthy, × 500. Fig. 3. L.s. ovule showing centripetal wall formation in endosperm (diagrammatic), × 10. Fig. 4. Magnified view of a nucellar embryo and endosperm, × 200. Fig. 5. L.s. young seed with endosperm haustorium (diagrammatic), × 8. Fig. 6. Enlargement of haustorium and adjacent nucellar cells from Fig. 5, × 50. Fig. 7. Micropylar portion of ovule, one of the nucellar cells is enlarging into the embryo-sac cavity, × 300. Fig. 8. Two-celled nucellar embryo, × 375. Fig. 9. Three adventive embryos, × 375. Fig. 10. L.s. upper half of the ovule with two smaller (*e*) and one larger (black) nucellar embryo, × 9. Fig. 11. Enlarged view of the two smaller nucellar embryos shown at *e* in Fig. 10, × 375.

While the endosperm is still in the free nuclear condition, one or more of the nucellar cells at the micropylar end, particularly those bordering the embryo-sac, become richly cytoplasmic (Fig. 7). The 'plasma-rich' cell (or cells) undergoes a transverse or a slightly

(Figs. 9-11). The nucellar embryos exhibit varying degrees of fusion, especially in the basal region.

Although several nucellar embryos may develop concurrently for a time, eventually one of them takes the lead and passes through the

globular and heart-shaped stages. The mature embryo is typically dicotyledonous and occasionally the massive cotyledons may be unequal. While the possibility of zygotic embryos cannot be ruled out, none of our preparations gave any evidence of it.

Attention may now be called to some other reports of polyembryony in the Rutaceæ. One zygotic and two or more nucellar embryos are formed in *Citrus*[5,6] species. In *C. paradisi* and *C. aurantium*,[1] besides the nucellar embryos, polyembryony is also due to the production of zygotic embryos from multiple gametophytes. Nucellar embryony also occurs in *Murraya kœnigi*,[2] *M. exotica*,[3] *Ptelea trifoliata*,[4] *Xanthoxylum bungei*[4] and *Triphasia aurantiola*.[4] In the last two species, a zygotic embryo is present side by side with the nucellar embryos.

Grateful thanks are due to Prof. P. Maheshwari for criticism and advice.

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SCILLA INDICA IN INDIA

Scilla indica Baker exhibits a high degree of multiformity in India, which has hitherto not been fully unravelled. An extensive study leading to an integration of morphological, cytological and distributional data has provided a full answer to the same. It is now reasonably clear that the underlying cause of its variation is the occurrence of chromosome races or cytotypes with $2n = 30$, 44, 45^3, 46^3, 58^5 and 60 chromosomes.

A critical study of the karyotype of plants with $2n = 30$, in comparison with the other available chromosome numbers in the genus,[1] leads one to think that they might have had an allopolyploid origin and hence are functional diploids. Based on the number 30, triploids with 45 and tetraploids with 60 somatic chromosomes are built up. The precise mode of origin of these forms is not yet clear. It is, however, possible to detect certain similar chromosome types in all the three karyotypes. Plants with 44, 46 and 58 somatic chromosomes referred to above are probably aneuploids at triploid and tetraploid levels. They may also be straight ploids based on 30.

Facts gathered from meiosis in PMCs fully affirm some of the above-mentioned conclusions. The functional diploids are usually characterised by the formation of 15 bivalents and regular disjunction, thereby ensuring good pollen fertility. The hypotriploids ($2n = 44$) show a variable number of trivalents, bivalents and univalents and are wholly sterile. The tetraploids show all types of configurations, the highest being tetravalents. It is, indeed, remarkable to observe that, despite the high chromosome number, tetraploids exhibit a greater tendency towards the formation of bivalents than tetravalents. This perhaps explains why to some extent they are propagated by seeds, although seed-setting is not so regular as in diploids. Multivalent formation in triploids and tetraploids is probably responsible for the origin of the aneuploid plants mentioned above (*cf.* Müntzing[2]).

This general chromosome survey, although incomplete in itself, nevertheless tells us that the evolutionary pattern in *Scilla indica* is determined by the establishment of the chromosome number 30 through polyploidy and subsequent hybridisation resulting in an array of morphologically more or less similar forms with different chromosome numbers. All these cytotypes have escaped the attention of the systematists so far.

When cytological results are combined with the taxonomic problem, the population of *Scilla indica* resolves itself into two natural groups. The diploids and tetraploids form one group, having almost similar morphological features. The triploids, on the other hand, form a group of their own and can readily be recognised on account of their linear-lanceolate leaves not encountered in the first group. Bulbils, so characteristically found at the tip of every leaf of the triploids, have not been observed in diploids and tetraploids. When all these facts are put together, the status of the diploids and triploids as species becomes indisputable. The taxonomic status of the tetraploids, however, is not yet clear.

Not only do chromosome races of *Scilla indica* vary in external morphological features but show characteristic differences in geographic distribution in India. Determination of the chromosome numbers of about 300 plants collected from different localities has revealed that diploid races occur in Bombay, Dharwar, Mysore and extend up to Tiruchirapalli. The triploids exist in the Coromandel Coast from Masulipatam to Madras. The tetraploids are found in the central parts of India (M.P.). The

TABLE I

Chromosome numbers of Scilla indica, *collected from different localities in India*

	Locality	2*n*	Meiosis	No. of plants studied
1	Bombay	30	Mostly II	20
2	Dharwar	30	,,	50
3	Mysore	30	,,	10
4	Tiruchirapalli	30	Mostly II	40
5	Madras	44	III, II and I	30
6	Masulipatam	44	,,	60
7	Madras	45, 46	Frequently III, II, and I; rarely IV, implying autosyndesis	Not known*
8	Sagar	58	,,	Very few†
9	Sagar	60	IV, III, II and I; a high frequency of II	60
10	Nagpur	60	,,	Few

* These were reported by Raghavan and Venkatasubban,[3] 1939. † These are very rare in nature.

aneuploids co-exist with their triploid and tetraploid relatives in their respective regions and nowhere else. It is an entirely plausible assumption that polyploid forms arose as a result of hybridisation in Peninsular India, south of the Vindhyas and the Satpuras. Hence, this part of Peninsular India is a seat of great evolutionary activity for *Scilla indica*. This closely agrees with the geographic distribution of *Ottelia alismoides* in India (Sundar Rao,[4] 1951). What is more, the fact that these two phylogenetically unrelated species have the same distribution pattern in India is of far-reaching significance.

To some extent, attention was also focussed upon the local variations in different chromosomal populations of *Scilla indica*. Interestingly enough, it shows ecologically adaptive divergence leading to the evolution of ecotypes. For instance, the diploid races occurring in Bombay and Tiruchirapalli are sharply different and so the triploid forms in Andhra and Madras. Whether it is ecotopic or ecoclimatic divergence or both, it still leaves the question open what role these local populations play in the evolution of new species.

Grateful thanks are due to Dr. A. C. Joshi, Prof. R. Misra and Prof. A. Müntzing (Lund, Sweden) for their kind interest in the investigation and to various Indian botanists for supplying the material.

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CYTOLOGY OF *GLORIOSA*

THIS liliaceous genus contains about 18 species (*vide* Index Kewensis) which inhabit mountains of tropical Asia and Africa. Some species are often cultivated for their beautiful showy flowers. The rhizomes and seeds could also be utilized as an alternative source for the alkaloid colchicine.[3] The cytology of this genus has received practically no attention so far. Chromosome numbers have been recorded for *G. carsonii*, *G. simplex*, *G. superba* and *G. rothschildiana*.[1,5,6] All the four species are diploid ($2n = 22$). No cases of intra- or interspecific polyploidy have been recorded so far.

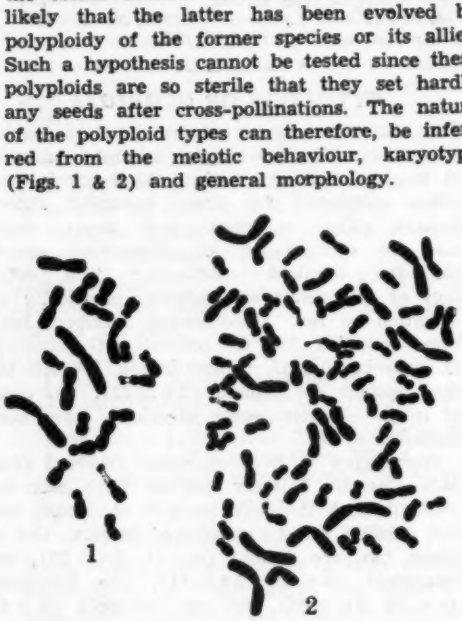
Karyotypes of five collections received from M/s. Chandra Nursery, Sikkim, have been investigated. A thorough analysis of meiosis was not possible due to paucity of flowers. Out of these, two are diploid ($n = 11$, $2n = 22$), one tetraploid ($n = 22$, $2n = 44$), one hexaploid ($n = 33$, $2n = 66$) and one octoploid ($n = 44$, $2n = 88$). The diploid types can be referred with certainty to *G. simplex* Linn. (*G. plantii* Loud.) and *G. superba* Linn. The taxonomy of the polyploid types is intricate and is being studied.

Details of this investigation will be discussed in another paper; however, some points deserve mention here. The diploid species have a normal meiosis. These produce normal pollen and set viable seed. In the polyploid types, though most of the associations at diakinesis are bivalents, yet many irregularities like multivalents, univalents, non-disjunction, anaphase bridges, laggards, tetrads with micronuclei and polyads do occur. As a consequence pollen is mostly sterile which results in practically no seed set. Perhaps sterility extends to megaspores also.

The author was able to collect hardly a dozen of seeds in two years from all the polyploid types. Out of these only one seed belonging to tetraploid germinated. This possessed 41

chromosomes ($4x-3$) in root tips. Furthermore, in the tetraploid type a small rhizome of triploid constitution was discovered in 1954. This rhizome has produced a plant which has not flowered so far.

The diploid *G. simplex* resembles the octoploid type except for the size and details of the colour scheme of the flower. It is quite likely that the latter has been evolved by polyploidy of the former species or its allies. Such a hypothesis cannot be tested since these polyploids are so sterile that they set hardly any seeds after cross-pollinations. The nature of the polyploid types can therefore, be inferred from the meiotic behaviour, karyotype (Figs. 1 & 2) and general morphology.



Chromosomes from root-tips pretreated with 0·0005 mol. solution of 8-0 q.

FIG. 1. *Gloriosa simplex*, $2n = 22$ (×1300).

FIG. 2. *G. species*, $2n = 88$ (× 1300.)

All the polyploid types though completely sterile, are preserved by efficient vegetative reproduction. For the same reason, balanced or unbalanced polyploidy is rather common in herbaceous perennials.[4] As against this, the sexually reproducing annuals always possess properly balanced polyploids since sterile combinations cannot produce any progeny.

It may be pointed out that this genus contains colchicine and possesses polyploid types in contrast to *Colchicum* which shows an aneuploid series.[2]

I am deeply indebted to Prof. P. N. Mehra for helpful suggestions, and to Mr. B. Khanna for help with the diagrams.

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THE SYNTHESES OF HUTTONITE AND MONAZITE

THE syntheses of huttonite and monazite by solid state reactions are here reported. Naturally occurring huttonite (monoclinic $ThSiO_4$) was discovered quite recently.[1] In attempting to synthesize $ThSiO_4$ in either the tetragonal thorite form or the monoclinic huttonite form, it was found that below 1,300° C. ThO_2 and SiO_2 reacted extremely sluggishly or not at all. The X-ray powder diffraction patterns of mixtures below 1,300° were those of thoria and silica. At temperatures slightly above 1,300° X-ray photographs revealed that the lines of thoria slowly faded with the gradual appearance of the lines of monoclinic thorium silicate although the reaction was still slow. It is interesting to note that by the solid state reaction method, the extremely rare naturally occurring monoclinic modification was directly formed and not the abundantly occurring tetragonal thorite.

Huttonite was then most conveniently synthesized by wet mixing under acetone 10·6 g. of ThO_2 [obtained by igniting extremely pure $Th(NO_3)_4.4H_2O$ at 1,200° C. for 12 hours] and 2·6 g. of SiO_2 (obtained by igniting pure silica gel) and heating the mixture at 1,500° C. for 96 hours. The mixture was removed from the furnace every 24 hours, pulverized, sieved through 200 mesh to ensure proper mixing and replaced. A 5% excess of silica was used to compensate for the volatilization losses at the high temperature employed.

As an initial attempt to synthesize monazite a single mixture of 95% monoclinic $CePO_4$ and 5% huttonite was used. Various methods given in the literature[2] for the preparation of $CePO_4$ were tried, but it was most conveniently synthesized by heating an appropriate mixture of

$Ce(NO_3)_3.4H_2O$ and $(NH_4)_2HPO_4$ to about 200°. The resulting $CePO_4$ was washed and heated to 700° when it readily changed over to the monoclinic form. 1·90 g. of this monoclinic $CePO_4$ and 0·10 g. of huttonite were wet mixed under acetone, dried and the mixture heated at 1,400° C. for 120 hours. During this period the mixture was quenched every 24 hours, pulverized and sieved as before to ensure homogeneity. The resulting mass which is light brown in colour, gave an X-ray pattern, the *d*-values of which were intermediate between those of $CePO_4$ and $ThSiO_4$ and the spacings and the relative intensities of which agreed closely with those of natural monazite.

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OBSERVATIONS OF DIRECT SOLAR AND DIFFUSE SKY RADIATION DURING SOLAR ECLIPSE

THE direct radiation from the sun and diffuse radiation from the sky were measured at Waltair during the solar eclipse on the 14th December 1955, making use of Gorczynski's Solarimeter in combination with Gorczynski's pyrheliometer.[1] Observations were taken at intervals of 10 minutes from just before the eclipse attained its full magnitude (13 hr. 22 min.) till the end (15 hr. 08 min.). Due to a slight dislocation of the original plan, regular recording of observations could not be secured until the eclipse progressed to an appreciable extent; the eclipse started at Waltair at 11 hr. 14 min. I.S.T.

The pyrheliometer gives the direct radiation from the sun's disc while the solarimeter measures the total radiation, *i.e.*, the diffuse radiation from all sections of the sky *plus* the vertical component of the direct solar radiation. By measuring the zenith distance of the sun by means of a pilot-balloon theodolite, the vertical component of the direct radiation from the sun could be computed from the cosine relation. The diffuse radiation from the sky was then obtained by subtracting the vertical component so computed from the solarimeter reading. The data are shown in Table I and are graphically represented in Fig. 1. For comparison, normal data for a few days in December, just preceding and following the eclipse-day, are also plotted in Fig. 1. The effect of the eclipse, which has a maximum phase of 0·65 at Visakhapatnam, on the incoming radiation is clearly seen in the figure.

TABLE I

Time in hours I.S.T.	Total radiation	Solar radiation	Zenith distance in degrees	Vertical component of Solar radiation	Diffuse radiation from sky
1310	0·39	0·42	45·0	0·30	0·09
1320	0·34	0·37	46·3	0·26	0·08
1330	0·32	0·41	47·9	0·28	0·04
1340	0·32	0·45	49·0	0·30	0·02
1350	0·34	0·47	50·5	0·30	0·04
1400	0·37	0·50	52·0	0·31	0·06
1410	0·41	0·57	53·7	0·34	0·07
1420	0·43	0·65	55·0	0·37	0·06
1430	0·45	0·70	56·5	0·38	0·07
1440	0·50	0·77	58·5	0·40	0·10
1450	0·50	0·80	60·0	0·40	0·10
1500	0·50	0·85	62·0	0·40	0·10
1510	0·47	0·87	64·0	0·38	0·09
1520	0·44	0·85	65·5	0·35	0·09

Note: All radiation measurements are in gram calories per sq. cm. per minute.

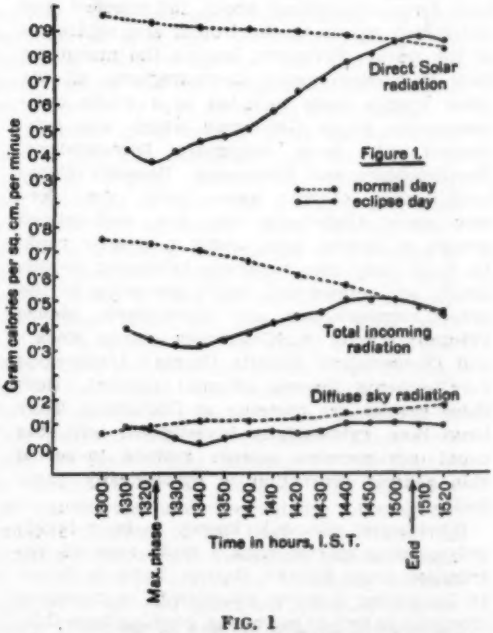

FIG. 1

As one would expect, the direct solar radiation is a minimum (0·37 g. cal./sq. cm./min.) at the time of the eclipse maximum, but the diffuse radiation is not. This is because the diffuse

radiation from the sky increases in amount with increase of the zenith angle of the sun and superposed on this increase is the variation due to the gradual clearing of the solar disc. In the absence of the eclipse, the diffuse radiation would be a minimum at the time of the minimum solar zenith distance (or local noon) while, with no variation in the position of the sun in the sky, the diffuse radiation should be a minimum when the eclipse is at its maximum. When these two effects are superposed on each other it can be seen that the minimum diffuse radiation epoch would accordingly be displaced; the observations show that this is around 1340 hours, I.S.T. The total radiation exhibits a variation that is intermediate between that of the direct solar and diffuse sky radiations.

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Andhra University, V. P. SUBRAHMANYAM.
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CYTOLOGY OF INDIAN GLEICHENIACEAE

GLEICHENIACEÆ is a primitive family of terrestrial ferns comprising about 130 species[1] and distributed mostly in the tropics and subtropics of the world. Formerly, leaving the monotypic New Caledonian genus *Stromatopteris*, all the other species were included in a single comprehensive genus *Gleichenia* which was subdivided into three subgenera *Dicranopteris*, *Eu-Gleichenia* and *Platyzoma*. Recently Copeland[1] and others have split the former genus *Gleichenia* into five well-defined groups of species each under a generic rank. In India only two members belonging to this family are represented which according to the latter nomenclature are *Hicriopteris glauca* (Thunb) Ching (= *Gleichenia glauca* Hook.) and *Dicranopteris linearis* (Burm.) Underwood [= *Gleichenia linearis* (Burm.) Clarke]. Both these species are common at Darjeeling. They have been cytologically investigated with the usual acetocarmine squash method to see if this generic distinction is cytologically justified.

Hicriopteris glauca is known to be a highly polymorphic species with a wide area of distribution from Malaya, Burma, India to Japan. In Darjeeling it grows abundantly in straggling stretches 20 feet or more long, forming huge thickets along roadside in open environments. The plants in this area represent a uniform population without any morphological variations. At metaphase, 56 bivalents are present in a number of mother cells (Fig. 1). The chromosomes show 1-2 chiasmata and assume usual configurations of X's, Y's, O's and V's. Meiosis

FIG. 1. *Hicriopteris glauca*, $n = 56$, × 935.
FIG. 2. *Dicranopteris linearis*, $n = 39$, × 1,260.

is perfectly normal resulting in tetrads with well filled spores which number 512 per sporangium. It will be difficult to judge the base number of this genus unless more species are investigated.

Dicranopteris linearis is also known to be a polymorphic species and Holttum[2] describes no less than six varieties from Malaya. In India the species is reported from various parts of Eastern Himalayas as far west as Kumaon and also from mountains of S. India and Ceylon.[3] At Darjeeling it is common, though by no means abundant, forming huge thickets scrambling on other plants along the fringes of the forests. Apparently the population in this area is uniform. Cytological investigation has shown 39 bivalents in a number of plants with perfectly normal meiosis resulting in 256-360 spores per sporangium (Fig. 2). This agrees with the observations of Manton and Sledge[4] who describe $n = 39$ for the var. *malayana* Christ growing in Malaya. They also recorded a tetraploid form with $n = 78$ from Kandy, Ceylon, which probably represented a shade-loving type.

The diversity of chromosome numbers 56 and 39 with no correlation between them exhibited by *H. glauca* and *D. linearis* cytologically justifies their segregation under two different genera done in the modern taxonomic treatment.

Dept. of Botany, P. N. MEHRA.
Panjab University, GURDIP SINGH.
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REVIEWS

Statistical Methods for Agricultural Workers. By V. G. Panse and P. V. Sukhatme. (Indian Council of Agricultural Research, New Delhi), 1956. Pp. xvi + 361. Price Rs. 15.

The volume under review has been written to meet the day-to-day needs of agricultural and biological workers and to serve as a suitable text for teaching the subject to the students of these two sciences. Part I with six chapters deals with useful statistical techniques and Part II with ten chapters deals with the design of experiments.

The authors try to fulfil their objective by limiting the scope of the book to the bare essentials, introducing formulæ without mathematical derivations and by using well chosen illustrative material in the discussion of statistical techniques. For instance, the authors consider multi-nominal distribution as beyond the scope of the book and content themselves by just mentioning its existence. The only formula proved (why?) is the partition of sum of squares in a two-way analysis of variance table. No formula seems to have escaped without being exhibited in its numerical aspects, an instructive technique one finds in the books of Sir Ronald A. Fisher.

Part II on the design of experiments is perhaps the more attractive, containing as it does very useful material particularly in the field of agriculture. The chapters towards the end of the book on groups of experiments and experiments on cultivator fields give a good introduction to problems of current research. Chapter VII on principles of field experimentation and Chapter XV on practical considerations contain useful tips to the practical workers. The rest of the chapters contain the description and analysis of designs which have been tried out in India. The authors could have been somewhat liberal in letting the readers know that there exists a greater variety of designs useful in plant breeding trials than what is treated in the book.

The appendices contain tables of significant values of t, F, χ^2 statistics, one, two and three digit random numbers.

The book seems to have been written with great care. However, a few mis-statements have crept in. For instance, the discussion of consistency on pages 85 and 94 is confusing. The interaction χ^2 on page 85 is interpreted as testing an unprecisely stated hypothesis. The volume will no doubt serve a useful purpose.

C. R. Rao.

Organic Insecticides—Their Chemisty and Mode of Action. By Robert L. Metcalf. (Interscience Pub.). Pp. x + 392. Price $8.50.

Insecticides are as important as drugs for the well-being of humanity. If drugs are curative, insecticides play a preventive role. Further, they are essential for the conservation of foodstuffs, development of agriculture and animal husbandry. Though considerable attention was given earlier to the control of insects, it is only during the present century that insecticides have come into their proper place. Originally plant materials were employed, but the insecticides now in common use are largely synthetic. The most important advance was the discovery of insecticides of plant origin having selective action, that is, toxic to insects and non-toxic to human beings and domestic animals. This has been followed by the preparation of synthetic chemicals having considerable selective action. The secret of the great success has been sought in the molecular structure of the concerned compounds.

The book under review gives an up-to-date account of the chemistry and the mode of action of organic insecticides. The chemical part describes in brief the chemical properties and molecular structure. More detailed information is given on the relation of structure to toxicity, mode of action and mammalian toxicology. Coming from an experienced entomologist these topics are excellently dealt with and the treatment will be useful both to chemists and to biologists concerned with the subject of insecticides. The order of treatment of the insecticides is a natural one, starting with plant materials like nicotine and its allies, rotenoids and pyrethroids followed by the synthetic insecticides in the order of their discovery and introduction into common use. Among the fourteen chapters in the book, one chapter of 30 pages is devoted to synergism, another chapter to insecticide-resistance, providing critical accounts of the two important topics. The book should therefore be a great help in stimulating orderly development of this subject of insecticides.

T. R. Seshadri.

Isotopic Gas Analysis for Biochemists. By R. F. Glascock. (Academic Press, Inc.), 1954. Pp. viii + 247. Price $ 5.80.

The advantages of using isotopic tracers for the solution of biochemical problems have been fully realised and the use of labelled compounds is now becoming common practice. Unfortunately, the isotopes most useful for the biochemists are amongst the most difficult to assay. The correct choice of the technique of assay for the problem in hand, therefore, may well decide progress. The book under review will prove of great value in this respect since it discusses the various procedures for the analysis of the isotopes of carbon, hydrogen and nitrogen, and presents the significant aspects of current development in isotopic gas analysis in a satisfactory manner. Though not an exhaustive treatise, the material presented should give it a wide use among biochemists contemplating the use of isotopic tracers.

In the introductory chapter, the advantages of gas phase analysis over other methods have been emphasised and a comparative survey of C^{14} counting techniques has been given. In Chapter 2, one of the primary requisites of the gas phase analysis—the vacuum manifold—has been dealt with in great detail. The description is eminently practical and leaves very little to be desired. The next two chapters are mainly devoted to the various methods of gas counting of carbon-14. The most recent methods have been included; counting apparatus and the elementary physics of counting have also been briefly touched. An account of the preparation of active samples for counting, by wet and dry combustion, has been given in Chapters 5 and 6. The next three chapters confine themselves to the methods of assay for isotopes of hydrogen—namely deuterium and tritium; the author has briefly mentioned the use of mass spectrometry and Popjak's falling drop method amongst other modern methods.

In Chapter 11, the methods of synthesis of some specific labelled compounds with the isotopes of hydrogen are given. This gives an idea of the technique to be adopted in general for obtaining desired labelled compounds. One would perhaps miss such a chapter for the other isotopes. Preparation of heavy nitrogen samples for mass spectrometric analysis has been given in Chapter 10; details of mass spectrometry as such are omitted. The book concludes with a brief description of *in vitro* oxidation procedures.

The twelve chapters are fully documented and contain a total of 105 references. These references with complete author and subject indexes enable one to easily find any topic discussed in the book. The style is pleasing, not too highly technical and easy to follow. The text is profusely illustrated wtih diagrams. The printing and the get-up of the book conform to the high standard of the Academic Press.

M. DAMODARAN.

Glutathione. *(Proceedings of the Symposium Held at Ridgefield, Connecticut, November 1953.)* Edited by S. Colowick, A. Lazarow, E. Racker, D. R. Schwarz, E. Stadtman, H. Waelsch. (Academic Press, New York), 1954. Pp. x + 341. Price $ 7.50.

The biochemical and other functions of glutathione have assumed great importance in recent years with the discovery of the significant role of sulphydryls (-SH) in various metabolic reactions. The volume under review gives an account of the proceedings of the symposium held at Ridgefield, Connecticut, U.S.A., in November 1953, of the twenty-nine scientific papers which were read and of the discussions which followed after presentation of each paper. Eminent biochemists like Melvin Calvin, Thedor Wieland, J. A. Stekol, A. Lazarow, Z. Dische, J. S. Fruton, Konrad Bloch and others have presented papers and have also participated in the discussions. The editors have conveniently divided the papers under the following four divisions: (i) Properties and Organic Chemisitry of Glutathione, (ii) Methods for Detection and Assay of Glutathione and Sulphydryl Compounds, (iii) Biochemical Mechanisms, and (*iv*) Physiological Actions and Clinical Aspects. The largest number of papers are under biochemical mechanisms and perhaps rightly so since extensive work has been done on this aspect in recent years. Among the topics discussed at length, under this division, particular mention may be made of the following: the biosynthesis and enzymic oxidation and reduction of glutathione, glutathione as a co-enzyme, the importance of glutathione in transpeptidation and the role of sulphydryl compounds in acyl transfer. Under methods, a review of chemical methods is presented as also an account of paper chromatography of glutathione and its hydrolysis products and the histochemical methods on sulphydryls and disulfides. The last section on physiological actions and clinical aspects deals with such topics as relation of glutathione to hormone action and diabetes as well as glutathione in radiation injury and in human disease. It must

be admitted, however, that the mechanism of action of glutathione in most of these clinical conditions is as yet unknown.

The volume under review can be considered to be of great value in that it will greatly help research progress by "emphasizing those scientific areas where more knowledge is urgently needed as well as by pointing out others in which further research does not appear profitable". The get-up of the book is excellent and Academic Press deserves praise for bringing out such a timely publication on an important subject in biochemistry.

P. S. SARMA.

The Diamond Tool Industry in 1955. (Issued by Industrial Diamond Information Bureau, 32/34, Holborn Viaduct, London, E.C. 1.) Pp. 12. Free of charge.

As in previous years, the Industrial Diamond Information Bureau has compiled a survey of the diamond tool industry, dealing with various scientific and technical aspects. Whilst no entirely new developments could be traced, practically all branches of the industry made important advances during the past year. The subject-matter, mainly based on the Bibliography of Industrial Diamond Applications, is subdivided into 16 main groups; about 200 references are quoted. The literature mentioned can be made available to enquirers.

The Chemical Industry in Europe. (Published by the O.E.E.C., 2, rue Andre, Pascal, Paris 16e.)

This excellent study constitutes the Second Annual Report drawn up by the Chemical Products Committee of the OEEC. (The first report was published in autumn 1954.) Part I of the report discusses in detail the various factors of supply and demand which affect the progress of the chemical industry. In Part II the chapters on various sectors are in general arranged as per the Standard International Trade Classification for Petroleum Chemicals. The range of the report is restricted to those sectors or groups of products for which information was available.

It is observed that the total value of the O.E.E.C. countries' chemical industry is estimated at $ 5,000 to 6,000 million in 1954 as compared to $ 9,000 million in 1954 for United States. Production of chemical industry in O.E.E.C. countries rose on an average by 15% over 1953. The expected expansion of the world nitrogen industry in the next few years causes apprehension as to the possibility of disposing of the quantity produced, and probably these countries will have to export the nitrogenous fertilisers to underdeveloped countries. One of the main concerns of the chemical industry in Europe is the recruitment of technical staff. With the rapid expansion of the chemical industry, demand for basic chemicals rose considerably in 1954, as home supplies of organic chemicals and crude chemicals from coal, petroleum, natural gas have been inadequate to meet the increased demand and the member-countries have had to import these from U.S.A. In Part II of the report data regarding production, imports and exports, and general trends of development of industry have been given for basic chemicals, petroleum chemicals, dye-stuffs, tanning materials, paints and related materials, soaps and detergents, fertilisers, plastic materials and miscellaneous chemical products. A study on sulphurous raw materials' position in 1954 is also annexed to the report. Such compiled data will be of immense use to all of those engaged in the chemical industry.

G. S. LADDHA.

Animal Nutrition. By E. J. Sheehy. (Macmillan & Co.), 1954. Pp. 731. Price 30 *sh.*

In this practical book, the author shows how scientific discoveries can increase the efficiency of production by economic and proper feeding of the farm animals. Though primarily written for the Irish farm conditions, it has worldwide applications in putting to practice the newer knowledge described here. Among the many important topics dealt in the 17 chapters are 'Quantitative Metabolism', 'The Farm Animal, Economy, Functions and Products', 'Mineral and Vitamin Deficiencies' and 'Antibiotics'. The first part of the book discusses animal physiology and fundamental nutrition. The second part deals with foods and food consumption. The third part is concerned with the economic production of milk, eggs and meat.

Professor Sheehy expresses in simple language and illustrates "how science leads to good practice in livestock husbandry and good practice leads to profitability". The nutrition of the modern dairy cow and the productivity of the laying fowl demand specialist feeding and management. Food alone constitutes on the average more than 60% of the cost of milk production and the economy of milk production depends on the cost of the food. Because of underfeeding the genetical capability of very many dairy cows is not being fully expressed. The cow with a long life-history

in the milking herd is a more economical animal than a similar one whose milking life is shorter. The author's own experiences with feeding of antibiotics are also mentioned as well as other newer results concerning animal feeding. He has succeeded in bridging the gap between scientific discovery in animal nutrition and its application in practice. This book will be of great interest and use to the students as well as livestock farmers who are striving hard to correct the world shortage of protective foods of animal origin.

V. R. RAJAGOPALAN.

Rothamsted Experimental Station Report for 1954.

The 1954 report of the Rothamsted Experimental Station records yet another year's successful progress in the various sections. Several lines of fundamental research are being carried on at the Station and may be expected to prove useful in applied science. It is, of course, very difficult, to do full justice to all aspects of the excellent work enumerated in the report and only the more salient points can be touched on.

For successful and efficient farming a good soil sturcture is a prerequisite. A new 'sodium saturation method' successfully applied for the determination of the crumb structure would enable the quantitative expression of soil structure. Further progress has been made in the physics department in the development of techniques for estimation of potash and phosphate status of soils. On the micro-meteorological side, interesting experiments on dew formation on grasses and potato have shown that dew is insignificant as a water source for the potato crop. In the chemistry department, besides continuing field experiments on horticultural crops, significant advances have been recorded in radio-tracer work on the uptake of phosphorus by cereal plants.

Further research on the nature of inhibition of root disease fungi by actinomycetes has brought out evidence to show that it is an antibiotic action and not a mere competition between the fungi and the antagonist for essential treatment. This is an important finding of interest to pathologists.

Experiments on the factors controlling the uptake of ions by excised roots have shown that the rate of potassium intake increased with higher concentration of fructose content but decreased with higher concentrations of glucose or sucrose. These observations will greatly aid in the proper understanding of the factors concerned in ion intake by roots.

The dependence of the oxidation velocity at physiological concentrations of Mn^{++} on the intensity of illumination and the amount of chlorophyll present in the chloroplast preparations has been indicated in the experiments conducted in the biochemistry department. This suggests that a Mn^{++} oxidation-reduction cycle may be involved in the reactions of photosynthesis.

The fascinating line of work of tissue culture as a method for obtaining virus-free plants from infected stalks is being carried out in the plant pathology department. Success along this line will enable the production of virus-free plants by culturing the excised stem meristems from infected plants. Progress has been made in the study of virus diseases affecting crops like potato, sugar beet, etc.

Paralysis due to CO_2 poisoning and the subsequent conditioning to such poisoning has been one of the very interesting observations reported by the insecticides and fungicides department. This finding will no doubt help to improve the laboratory technique for the assay of insecticides and fumigants.

Soil science and the Rothamsted Station have suffered a grievous loss in the death of Dr. E. M. Crowther during 1954. This classified list of publications by Dr. Crowther appended to the report brings together the activities of a person who dedicated his life for the advancement of soil science.

As the previous reports, this report should also prove of interesting and informative reading to all physico-chemical and biological scientists. The get-up of the report conforms to the usual high standard and perfection.

N. L. DUTT.

Books Received

Physics of Fully Ionized Gases. By Lyman Spitzer, Jr. (Interscience), 1956. Pp. ix + 105. Price $ 1.75.

The Chemistry and Reactivity of Collagen. By K. H. Gustavson. (Academic Press), 1956. Pp. ix + 342. Price $ 8.00.

Germanium Diodes. By S. D. Boon. (Philips Technical Library), 1956. Pp. viii + 85. Price not given.

Progress in Nuclear Energy, Series I. (Physics and Mathematics), Vol. I. Edited by R. A. Charpie, S. T. Horowitz, D. J. Hughes and D. J. Littler. (Pergamon Press), 1956. Pp. x + 398. Price 70 *sh.*

SCIENCE NOTES AND NEWS

Elimination of Static Electricity by Radioactive Substances

A method of eliminating static electricity by means of radioactive preparations has been elaborated by the safety techniques department of the Moscow Institute of Chemical Machine-Building. Radioactive polonium-210 which emanates alpha particles, is used for this purpose. A metal plate with a thin coating of polonium-210 is hung in the area of charge formation; this ionises the air and neutralises the static electricity. The danger of injury, fire and explosion from static electricity is thus eliminated.

Measurements of Deep Ocean Currents

For the first time, direct and reliable measurements of the currents in the deep ocean basins have been made free from the uncertainties involved in using a conventional current meter from an anchored ship. Dr. J. C. Swallow, of the National Institute of Oceanography, has developed a technique whereby a neutrally buoyant float can be followed for several days by listening to the acoustic signals that it transmits. The density of the float, which consists principally of two 10' aluminium scaffold tubes sealed at the ends, is carefully adjusted to be greater than that of water at the surface of the sea and less than that of the bottom water, so that it floats at a predetermined depth in midwater.

New Metals for Nuclear and Jet Power

Air speeds of the order of Mach 3 and 4 are now considered to be round the corner, and speeds of the order of Mach 15 are considered to be the next horizon. Such speeds cannot be attained with normal fuels, and research is now proceeding to develop the use of metallic fuels, and boron compounds such as one of the boron hydrides may well produce the power necessary to push machines through whichever barrier may be between them and Mach 15. Among less spectacular and speculative metals it is possible to name several which will almost certainly play a part in the future progress of nuclear of jet power. Berylium, zirconium, tantalum, niobium, and molybdenum would be included in such a list.

Atomic Energy Board in USSR

A Central Atomic Energy Board under the USSR Council of Ministers has been organized to promote broad application of atomic energy in all branches of the national economy of the USSR and co-operation of the Soviet Union with other countries in the peaceful uses of atomic energy. The Central Board is charged with developing atomic reactors for power stations and other power installations and guiding research in exploring other ways of using atomic energy. Prof. Efim Slavsky has been appointed Chief of the Central Atomic Energy Board.

Regional Research Laboratory, Hyderabad

The Central Laboratories for Scientific and Industrial Research, so far working under the Government of Hyderabad State, were formally taken over by the Council of Scientific and Industrial Research, Government of India, as from April 1, 1956. Under its new name of Regional Research Laboratory, Hyderabad, it now becomes the first regional laboratory of the Council of Scientific and Industrial Research, retaining its characteristic features and basic research programmes. Dr. S. Husain Zaheer remains as Director and the research staff continue as before. This step now assures the full development originally planned for this laboratory.

International Congress on Cybernetics

An International Congress on Cybernetics is to be held in Namur, Belgium, from June 26 to 29, 1956, under the sponsorship of the Belgian Ministry of Education and UNESCO. The work of the Congress will be divided into four sections. The first, under the Chairmanship of Professor Pierre Auger, Director of UNESCO's Department of Natural Sciences, will consider principles and methods of cybernetics, including information theory, learning, operational research, theory of games, etc. The second, on semantic machines, which deals with computing and translating machines, multi-purpose logical machines and many others, will have for its Chairman, Dr. Louis Couffignal, Director of the Automatic Computation Laboratory in Paris.

The third section, concerned with the latest developments in automation, will be under the Chairmanship of Professor Georges R. Boulanger of Brussels University who is President of the Congress. Fourthly, a group presided over by Dr. W. Grey Walter, of the Burden Neurological Institute in the United Kingdom, will discuss the impact of cybernetics on biology, physiology, medicine, psychology, social sciences, etc.

Value to Dairymen of Radioactive Materials

According to Dr. C. W. Turner, of the Dairy Department of the University of Missouri, the use of radioactive iodine to determine thyroxine secretion rate in cattle may be valuable to dairymen when selecting breeding stock; for, all hormones involved in lactation need to be secreted at optimum levels for maximum and continued high levels of milk production. Therefore, ways to measure hormone secretion rate are needed so that breeders of dairy cattle may locate the cause of low milk production.

Dr. Turner sees current and future studies of endocrine gland secretion as helpful in two ways. One is long range—the making of measurements that will be helpful to breeding better stock. The other is immediate—use of methods to supplement the animal's own secretion of these hormones where it is less than optimum.

Work at the Missouri station has already shed considerable light on methods of supplementing deficiencies. Dr. Turner and co-workers have developed iodinated casein for feeding to dairy cows with sluggish thyroid glands. This material can be used to stimulate milk production after the cows have passed their peak in natural production.

Traces of Aureomycin for Food Preservation

A new method of food preservation was recently demonstrated at the National College of Food Technology, Smithfield, England. Dr. John H. Taylor, who is co-ordinating research on the subject, observes that the addition of a minute amount of antibiotic aureomycin to perishable foodstuffs maintains the freshness by retarding the growth of spoilage bacteria which otherwise cause rapid deterioration. The method, called 'acronizing', has been acclaimed as the greatest advance in the field of processing perishable foods since the advent of refrigeration some 25 years ago. Only "trace" amounts of aureomycin are required and research has shown that it all disappeared after cooking. None of the antibiotic was actually consumed.

FAO Fisheries Officer for Asia and the Far East

Mr. Colin Beever, Fisheries Economist from the Headquarters of the Food and Agricultural Organization, Rome, has been appointed Acting Regional Fisheries Officer for Asia and the Far East, Mr. Beever has represented Fisheries Division, FAO, at various meetings, and was Associate Director of the Training Centre for Fishery Administrators which was held in Copenhagen, Denmark, in September and October last year.

Colonel Amir Chand Trust Prizes for Medical Research

It has been decided to award during 1956 six prizes of the value of Rs. 300 each for the best published research work in any subject pertaining to all fields of medical sciences including clinical research, during the year 1955. The award of the prizes will be announced by the Indian Council of Medical Research, during November/December 1956.

The candidates are required to submit 10 reprints of their papers published during 1955. These should be sent to the Director, Indian Council of Medical Research, P. Block, Raisina Road, P.O. Box 494, New Delhi, so as to reach him not later than the 1st August 1956. The papers should be accompanied by a short biographical sketch and two copies of passport size photographs of the worker or workers concerned.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree in Pharmacy to Sri. B. V. Rama Sastry for his thesis entitled "Investigations on Leguminous Plant Insecticides and Fish Poisons".

The University of Poona has awarded the Ph.D. Degree in Botany to Shri M. S. Chennaveeraiah for his thesis entitled "Cytoembryological Studies on *Dipcadi medic.* (Fam. Liliaceæ) and *Hyphæne* (Gaertn. (Fam. Palmae), with a note on the Karyotypes in the Marsileaceæ"; and to Shri B. Biswas for his thesis entitled "Ferns of Bombay State: The Structure and Life-History of *Anisgonium esculentum* Presl. and Some Acrostichoid Ferns".

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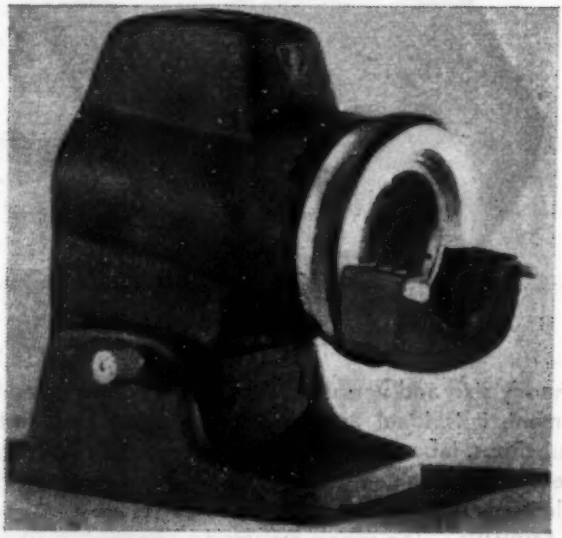

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